Operating Instructions 07/2007 Edition

SINAMICS G130

Built-in unit converter
75 kW to 800 kW

sinamics

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SINAMICS G130
Inverter chassis units

Operating Instructions

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Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

⚠DANGER
indicates that death or severe personal injury **will** result if proper precautions are not taken.

⚠WARNING
indicates that death or severe personal injury **may** result if proper precautions are not taken.

⚠CAUTION
with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

CAUTION
without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

NOTICE
indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

Prescribed Usage

Note the following:

⚠WARNING
This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

Trademarks

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Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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℗ 09/2007

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Preface

User documentation

⚠ WARNING
Before installing and commissioning the converter, make sure that you read all the safety notes and warnings carefully, including all the warning labels on the components. The warning labels must always be legible. Missing or damaged labels must be replaced.

Further information is available from:

Technical support

- Tel: +49 (0) 180 50 50 222
- Fax: +49 (0) 180 50 50 223
- Internet: http://www.siemens.de/automation/support-request

Internet address

Information about SINAMICS can be found on the Internet at the following address:
http://www.siemens.com/sinamics

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Safety information

1

1.1 Warnings

⚠ WARNING

Hazardous voltages are present in this electrical equipment during operation.
Non-observance of the warnings can result in severe personal injury or property damage.
Only qualified personnel should work on or around the equipment.
These personnel must be thoroughly familiar with all warning and maintenance procedures described in these operating instructions.
The successful and safe operation of this device is dependent on correct transport, proper storage and installation, as well as careful operation and maintenance.
National safety guidelines must be observed.

Certification

The following certificates can be found under "Safety and Operating Instructions" in the documentation folder:

- EC declaration of conformity
- Certificate of compliance with order
- EC manufacturer's declaration

1.2 Safety and operating instructions

⚠ DANGER

This equipment is used in industrial high-voltage installations. During operation, this equipment contains rotating and live, bare parts. For this reason, they could cause severe injury or significant material damage if the required covers are removed, if they are used or operated incorrectly, or have not been properly maintained.
When the machines are used in non-industrial areas, the installation location must be protected against unauthorized access (protective fencing, appropriate signs).

Prerequisites

Those responsible for protecting the plant must ensure the following:

- The basic planning work for the plant and the transport, assembly, installation, commissioning, maintenance, and repair work is carried out by qualified personnel and/or checked by experts responsible.
- The operating manual and machine documentation are always available.
- The technical specifications regarding the applicable installation, connection, environmental, and operating conditions are always observed.
- The plant-specific assembly and safety guidelines are observed and personal protection equipment is used.
- Unqualified personnel are forbidden from using these machines and working near them.

This operating manual is intended for qualified personnel and only contain information and notes relating to the intended purpose of the machines.

The operating manual and machine documentation are written in different languages as specified in the delivery contracts.

Note

We recommend engaging the support and services of your local Siemens service center for all planning, installation, commissioning and maintenance work.

1.3 Components that can be destroyed by electrostatic discharge (ESD)

⚠ CAUTION

The board contains components that can be destroyed by electrostatic discharge. These components can be easily destroyed if not handled properly. If you do have to use electronic boards, however, please observe the following:

- You should only touch electronic boards if absolutely necessary.
- When you touch boards, however, your body must be electrically discharged beforehand.
- Boards must not come into contact with highly insulating materials (such as plastic parts, insulated desktops, articles of clothing manufactured from man-made fibers).
- Boards must only be placed on conductive surfaces.
- Boards and components should only be stored and transported in conductive packaging (such as metalized plastic boxes or metal containers).
- If the packaging material is not conductive, the boards must be wrapped with a conductive packaging material (such as conductive foam rubber or household aluminum foil).

The necessary ESD protective measures are clearly illustrated in the following diagram:

- a = conductive floor surface
- b = ESD table
- c = ESD shoes
- d = ESD overall
- e = ESD wristband
- f = cabinet ground connection
- g = contact with conductive flooring

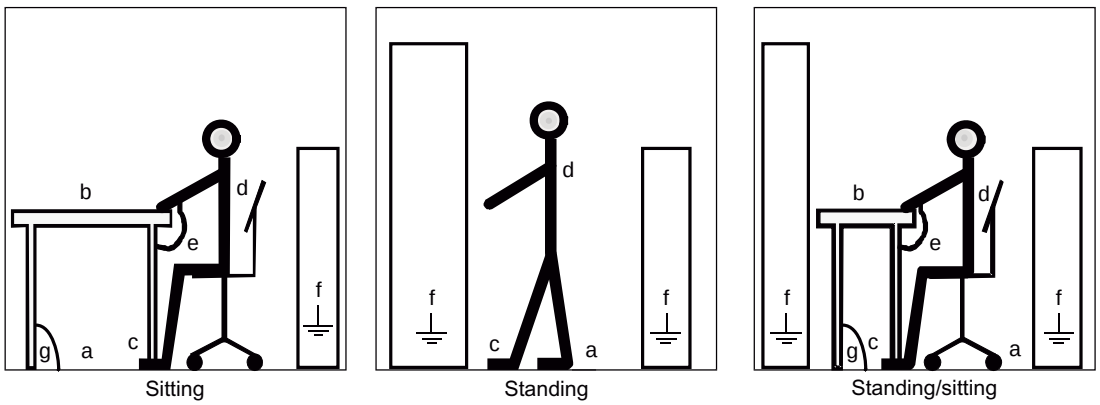


Figure 1-1 ESD protective measures

Residual risks of power drive systems

When carrying out a risk assessment of the machine/plant in accordance with the EU Machinery Directive, the machine manufacturer/plant operator must consider the following residual risks associated with the control and drive components of a power drive system (PDS).

1. Unintentional movements of driven machine components during commissioning, operation, maintenance, and repairs caused by, for example:
   - Hardware defects and/or software errors in the sensors, controllers, actuators, and connection technology
   - Response times of the controller and drive
   - Operating and/or ambient conditions not within the scope of the specification
   - Parameterization, programming, cabling, and installation errors
   - Use of radio devices / cellular phones in the immediate vicinity of the controller
   - External influences / damage
2. Exceptional temperatures as well as emissions of light, noise, particles, or gas caused by, for example:
   - Component malfunctions
   - Software errors
   - Operating and/or ambient conditions not within the scope of the specification
   - External influences / damage
3. Hazardous shock voltages caused by, for example:
   - Component malfunctions
   - Influence of electrostatic charging
   - Induction of voltages in moving motors
   - Operating and/or ambient conditions not within the scope of the specification
   - Condensation / conductive contamination
   - External influences / damage
   - Improper protective conductor connection at high leakage currents.
4. Electrical, magnetic, and electromagnetic fields that can pose a risk to people with a pacemaker and/or implants if they are too close.
5. Emission of pollutants if components or packaging are not disposed of properly.

An assessment of the residual risks of Power Drive System components (see points 1 to 5 above) established that these risks do not exceed the specified limit values.

For more information about residual risks of the Power Drive System components, see the relevant chapters in the technical user documentation.

Device overview

2

2.1 Chapter content

This chapter provides information on the following:

- Introduction to the chassis units
- The main components and features of the chassis units
- The chassis unit wiring
- Explanation of the type plate

2.2 Overview of the chassis units

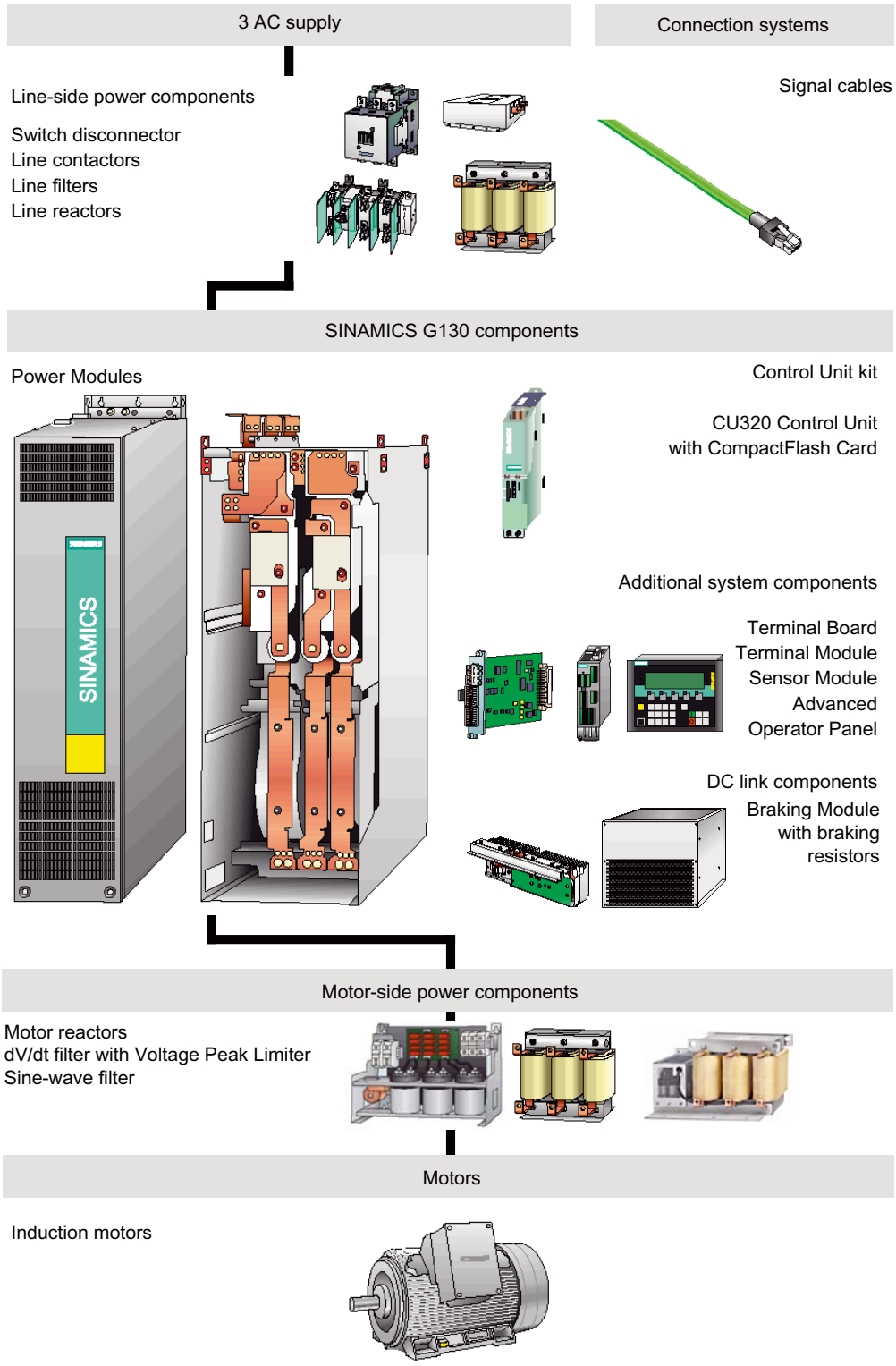


Figure 2-1 Overview of the chassis units

2.3 Overview of the Power Modules

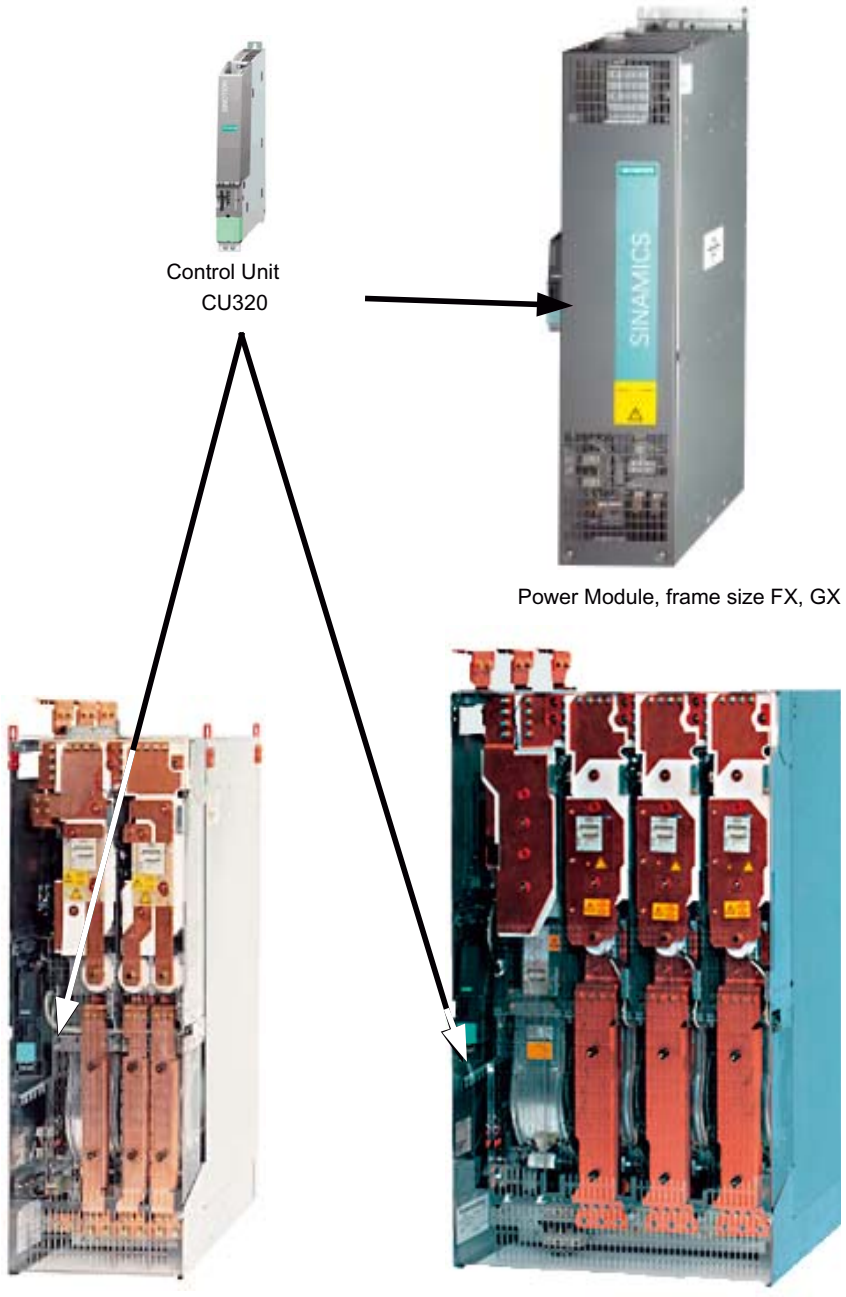


Figure 2-2 Overview of the Power Modules

2.4 Applications, features, and design

2.4.1 Applications

SINAMICS G130 chassis units are specially designed to meet the requirements of variable-speed drives with a quadratic and constant load characteristic, medium performance requirements, and no regenerative feedback.

As a result, SINAMICS G130 chassis units are a cost-effective drive solution for all types of industrial applications that involve moving, conveying, pumping, compressing, or extracting solids, liquids, or gases.

2.4.2 Features, quality, service

Features

From configuration to operation, SINAMICS G130 chassis units are easy to use and offer the following benefits:

- Compact, modular, and service-friendly design.
- Straightforward planning and design thanks to the Sizer and Starter tools.
- Ready to connect to facilitate the installation process.
- Quick and easy commissioning thanks to practical menu guidance and integrated optimization routines.
- SINAMICS G130 chassis units are an integral part of Totally Integrated Automation (TIA). The TIA concept offers an optimized range of products for automation and drive technology. This concept builds on configuration, communication, and data management procedures that are consistent throughout the product range. SINAMICS is fully integrated in the TIA concept.
  Separate S7/PCS7 blocks and faceplates for WinCC are available.
- A user-friendly graphical operator panel with measured values, messages, and a quasi-analog display for measured values is also available as an option.
- Integration in SIMATIC H systems is possible via a Y link.

Quality

SINAMICS G130 chassis units are manufactured to meet high standards of quality and exacting demands.

This results in a high level of reliability, availability, and functionality for our products.

The development, design, and manufacturing processes, as well as order processing and the logistics supply center have been certified to DIN ISO 9001 by an independent authority.

Service

Our worldwide sales and service network offers our customers consulting services tailored to their needs, provides support with planning and design, and offers a range of training courses.

For detailed contact information and the current link to our Internet pages, see "Service and Support".

2.5 Wiring principle

Wiring principle for SINAMICS G130

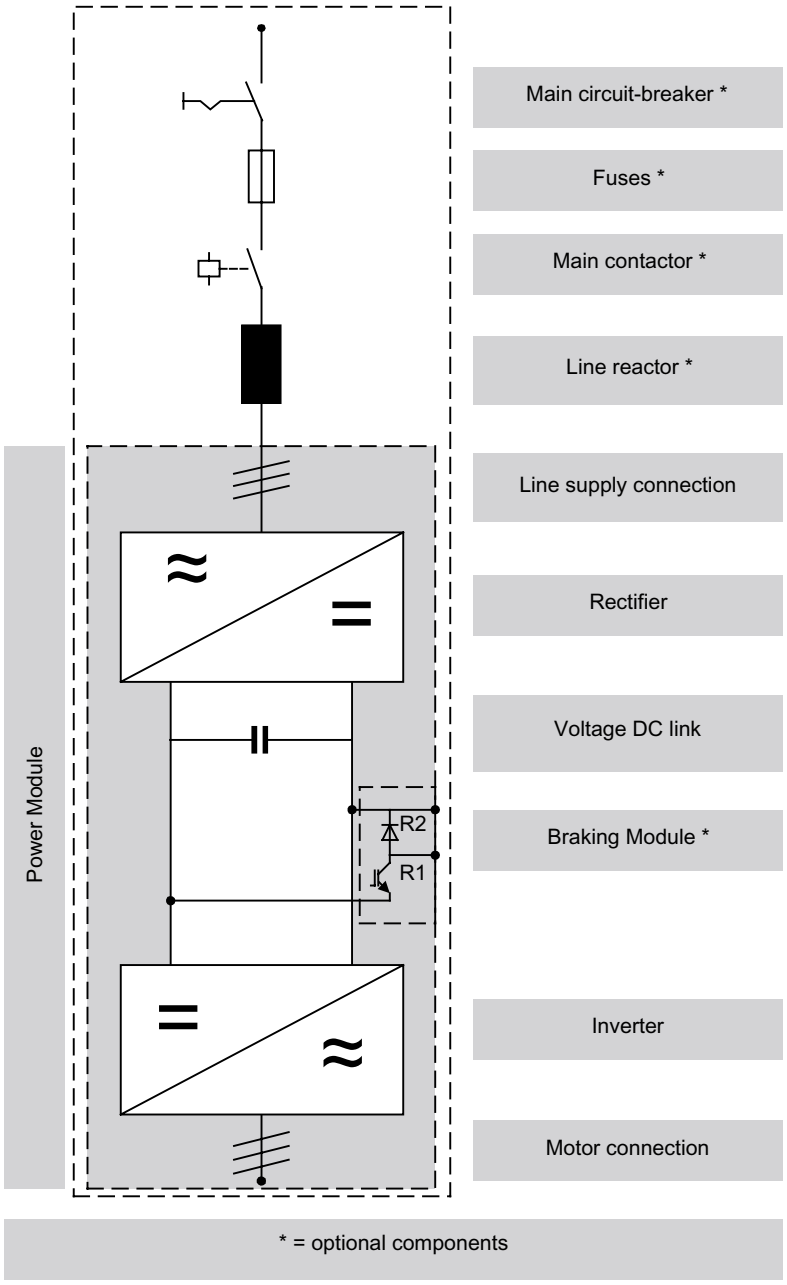


Figure 2-3 Wiring principle for SINAMICS G130

2.6 Type plate

Specifications on the type plate

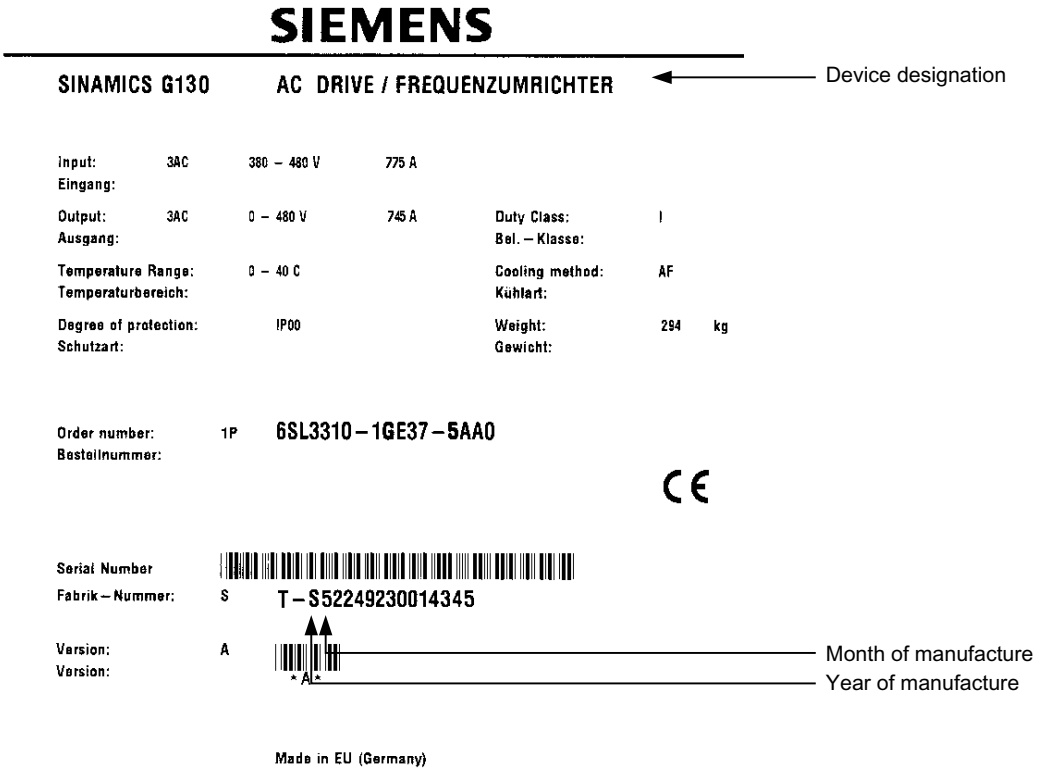


Figure 2-4 Type plate for the chassis units

Date of manufacture

The date of manufacture can be determined as follows:

Table 2-1 Production year and month

Letter/number	Year of manufacture		Letter/number	Month of manufacture
T	2005		1 to 9	January to September
U	2006		O	October
V	2007		N	November
W	2008		D	December

Type plate specifications (from type plate above)

Table 2-2 Specifications on the type plate

Specification	Value	Explanation
Input	3 AC 380 – 480 V 775 A	Three-phase connection Rated input voltage Rated input current
Output	3 AC 0 – 480 V 745 A	Three-phase connection Rated output voltage Rated output current
Temperature range	0 – 40°C	Ambient temperature range within which the chassis unit can operate under 100% load
Degree of protection	IP20 IP00	Degree of protection
Duty class	I	I: Duty class I to EN 60146-1-1 = 100 % (continuously) (with the specified current values, the chassis unit can operate continuously under 100 % load)
Cooling method	AF	A: Cooling medium: air F: circulation method: forced cooling, drive unit (fan) in the device
Weight		Weight

Mechanical installation

3

3.1 Chapter content

This chapter provides information on the following:

- The conditions for installing the chassis units and optional components.
- The preparations for installing the chassis units and optional components.

3.2 Transportation and storage

Transportation

⚠WARNING

The following must be taken into account when the devices are transported:

- The devices are heavy. Their center of gravity is displaced, and they can be top heavy.
- Suitable hoisting gear operated by trained personnel is essential due to the weight of the devices.
- The devices must only be transported in the upright position indicated. The devices must not be transported upside down or horizontally.
- Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.

Note

Notes regarding transportation

- The devices are packaged by the manufacturers in accordance with the climatic conditions and stress encountered during transit and in the recipient country.
- The notes on the packaging for transportation, storage, and proper handling must be observed.
- The devices must be carried on a wooden palette when transported with fork-lift trucks.
- When the devices are unpacked, they can be transported using the transport eyebolts attached. The load must be distributed evenly. Chains attached to the transport eyebolts must only be loaded vertically from above. Heavy blows or impacts must be avoided during transit and when the devices are being set down, for example.
- Permissible ambient temperatures:
  Ventilation: -25°C to +70°C, class 2K3 to IEC 60 721-3-2
  Down to -40°C for max. 24 hours

Note

Notes regarding built-in line-side components

If built-in line-side components are to be installed on the devices, the following points must be taken into account:

- The degree of protection must not be reduced as a result.
- The electromagnetic compatibility of the device must not be adversely affected.

Note

Notes regarding damage in transit

- Carry out a thorough visual inspection of the device before accepting the delivery from the transportation company.
- Ensure that you have received all the items specified on the delivery note.
- Notify the transportation company immediately of any missing components or damage.
- If you identify any hidden deficiencies or damage, contact the transportation company immediately and ask them to examine the device.
- If you fail to contact them immediately, you may lose your right to claim compensation for the deficiencies and damage.
- If necessary, you can request the support of your local Siemens branch.

⚠ WARNING

Damage in transit indicates that the device was subject to unreasonable stress. The electrical safety of the device can no longer be ensured. It must not be connected until a thorough high-voltage test has been carried out.

Death, serious injury, or substantial material damage can result if these factors are not taken into account.

Storage

The devices must be stored in clean, dry rooms. Temperatures between –25°C and +70°C are permissible. Temperature variations greater than 20 K per hour are not permitted.

If the device is stored for a prolonged period once it has been unpacked, cover it or take other appropriate measures to ensure that it does not become dirty and that it is protected against environmental influences. If such measures are not taken, the guarantee becomes invalid in the event of a claim for damages.

⚠ WARNING

The device should not be stored for more than two years. If the device is stored for more than two years, the DC link capacitors of the devices must be reformed during commissioning.

The reforming procedure is described in "Maintenance and Servicing”.

3.3 Assembly

⚠ WARNING

To ensure that the devices operate safely and reliably, they must be properly installed and commissioned by qualified personnel, taking into account the warnings provided in these operating instructions.

In particular, the general and national installation and safety guidelines for high-voltage installations (e.g. VDE – the Union of German Technical Engineers) as well as the guidelines relating to the proper use of tools and personal protective equipment must be observed.

Death, serious injury, or substantial material damage can result if these factors are not taken into account.

3.3.1 Preparation

On-site requirements

The chassis units are suitable for installation in general operating areas (DIN VDE 0558/Edition 7.87, Part 1/Section 5.4.3.2.4).

The standard specifies the following:
When power converter units are installed in general operating areas, live parts must be protected in such a way that they cannot be touched either directly or indirectly.

The operating areas must be dry and free of dust. The air supplied must not contain any electrically conductive gas, vapors, or dust, which could impair operation. It may be necessary to filter the air supplied to the installation room.

The ambient conditions for the units in the operating rooms must not exceed the values of code F in accordance with EN 60146. At temperatures > 40°C (104°F) and installation altitudes > 2000 m, the devices must be derated.

Built-in units with frame sizes FX and GX comply with degree of protection IP20; with frame sizes HX and JX, they comply with degree of protection IP00 to EN 60529.

The chassis units are installed in accordance with the dimension drawings supplied. The clearance between the top of the devices and the ceiling is also specified on the dimension drawings.

The cooling air for the power unit is drawn from the lower part of the device. The warmed air is expelled through the heat sink. When installing the device in cabinet units, you must ensure that suitable barriers are in place to ensure that the warmed air is not drawn back into the suction area of the heat sink.

According to EN 61800-3, the built-in unit is not suitable for use in low-voltage public networks that supply residential buildings. High-frequency interference may occur if they are used in this type of network.

Unpacking the cabinets

Check the delivery against the delivery note to ensure that all the items have been delivered. Check that the devices are intact.

The packaging material must be discarded in accordance with the applicable country-specific guidelines and rules.

Required tools

To install the connections, you will require:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver, size 2
- Screwdriver Torx T20
- Screwdriver Torx T30

3.4 Power Module

Description

The Power Module is the power unit of an AC-AC converter. Line or motor-side components can be added to create a converter system. If required (e.g., for braking operation), a Braking Module can also be installed in the DC link of the converter. A slot is provided in the Power Module for this purpose.

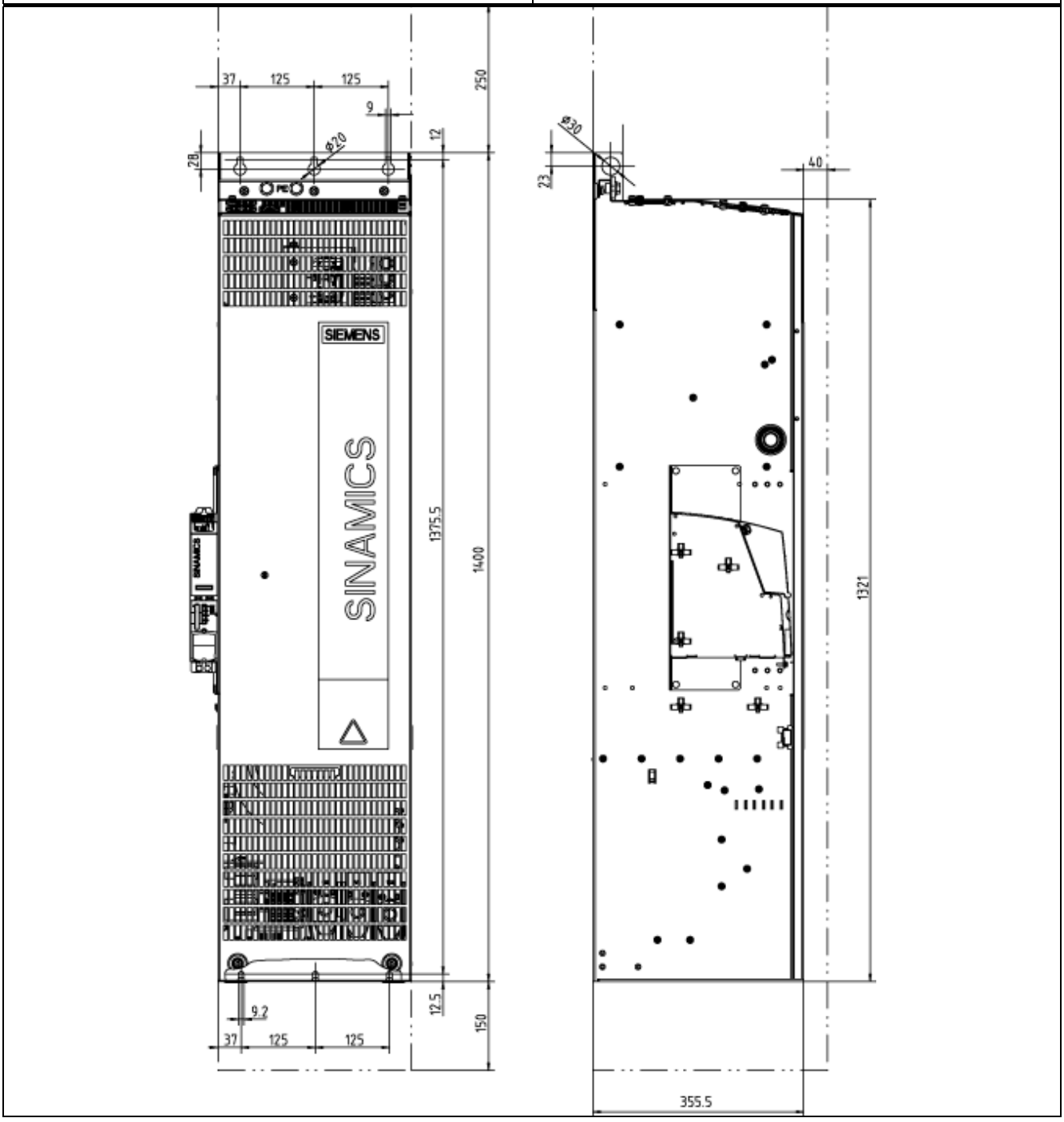
The Power Module creates an output voltage with variable amplitude and frequency from a supply voltage with constant amplitude and frequency.

⚠ CAUTION
The ventilation clearances above, below, and in front of the Power Module, which are specified in the dimension drawings, must be observed. If these clearances are not observed, this can result in a thermal overload of the Power Module.

3.4.1 Dimension drawings

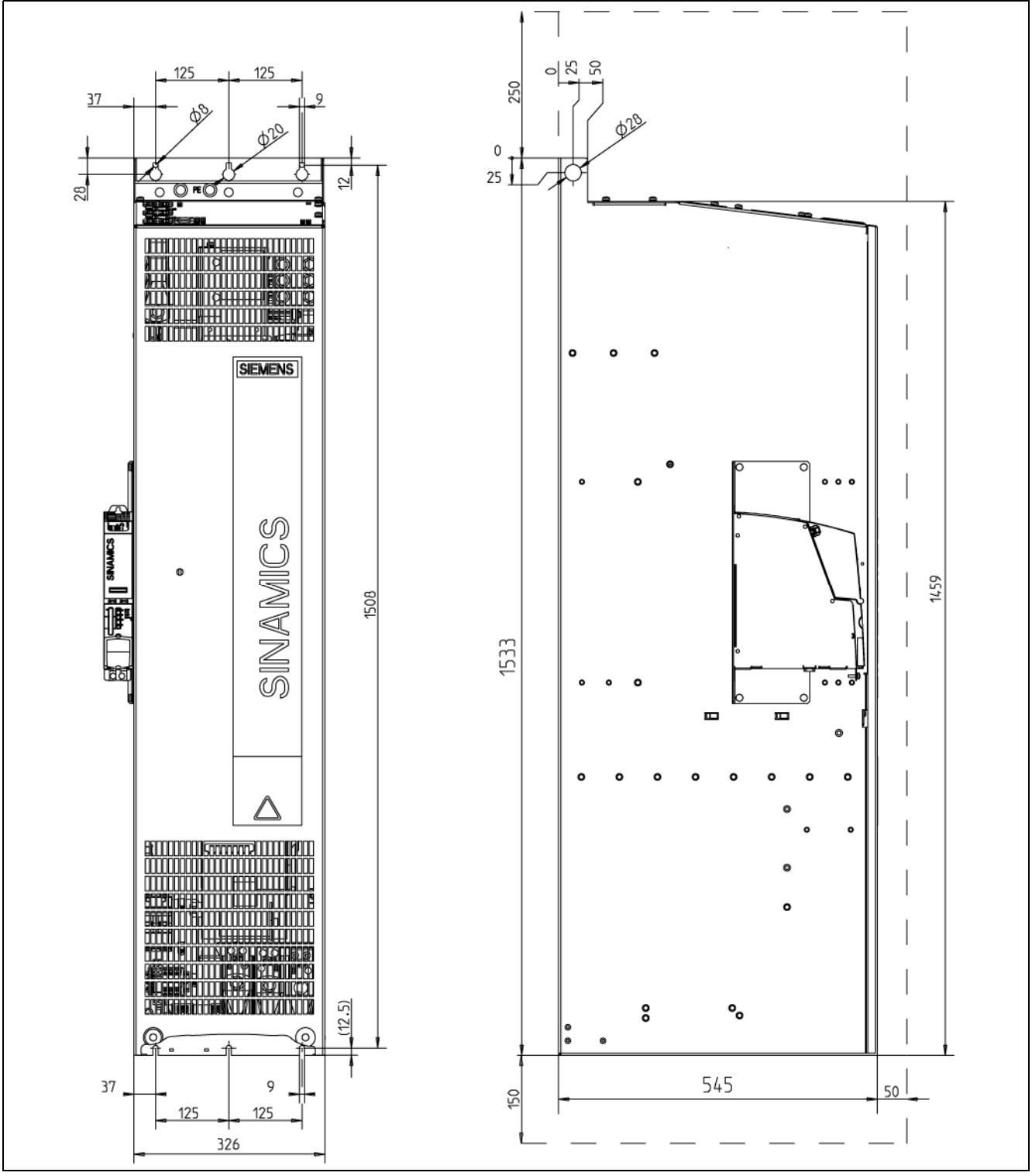
Dimension drawing frame size FX

Table 3-1 Dimension drawing frame size FX

Front view	Side view
	

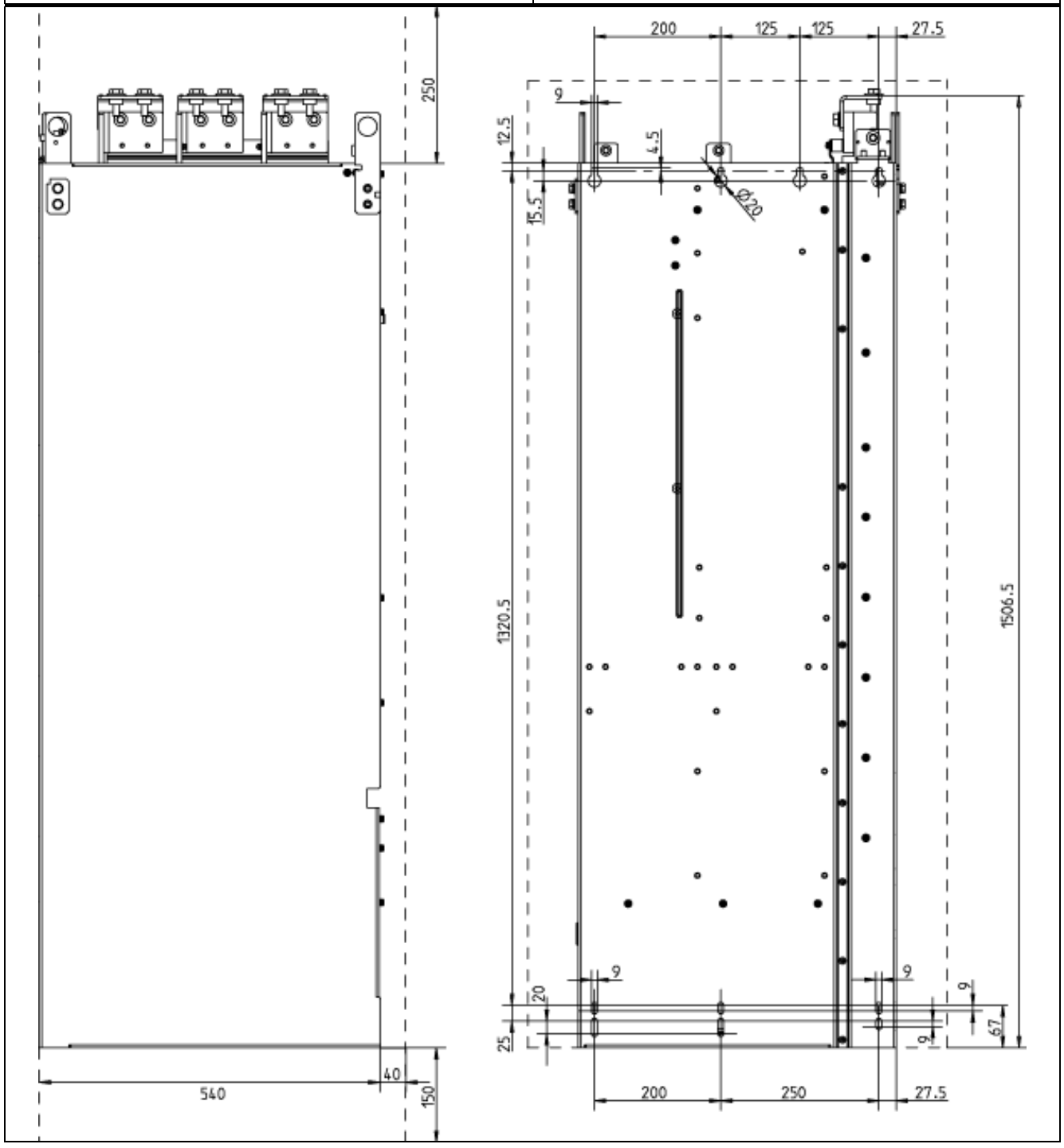
Dimension drawing (frame size GX)

Table 3-2 Dimension drawing (frame size GX)

Front view	Side view
	

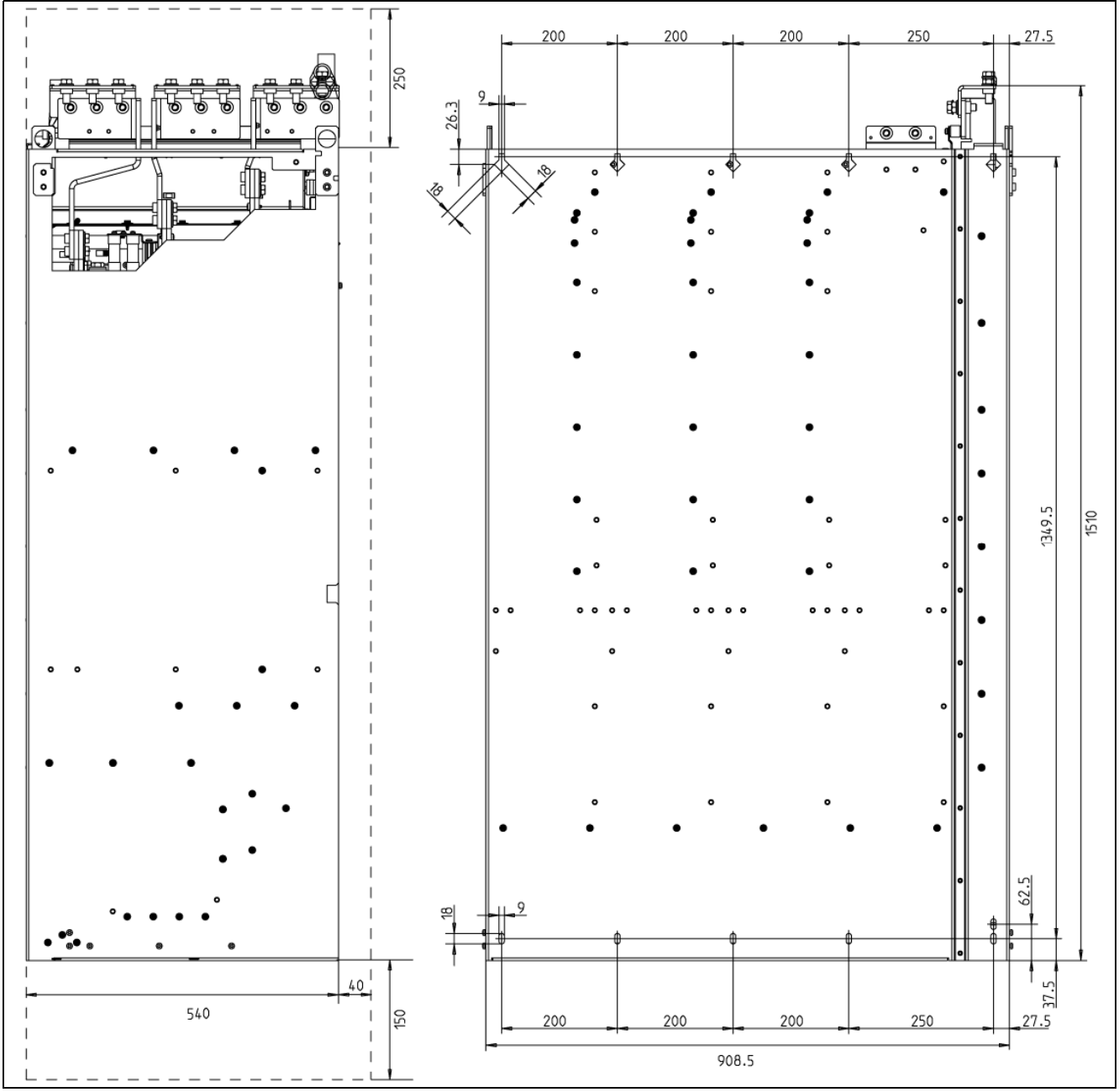
Dimension drawing (frame size HX)

Table 3-3 Dimension drawing (frame size HX)

Side view	Rear view
	

Dimension drawing (frame size JX)

Table 3-4 Dimension drawing (frame size JX)

Side view	Rear view
	

⚠ WARNING

The Power Modules can be lifted using the lifting eyebolts attached. A lifting harness with a vertical rope or chain must, however, be used. The device must not be lifted at an angle because this can damage the housing or connection busbars. Rope spreaders may have to be used.

⚠ WARNING

For Power Modules of frame sizes HX and JX, the hoists must be removed once the devices have been installed.

3.5 Control Unit CU320

Description

The CU320 is the central Control Unit in which the closed-loop and open-loop control functions are implemented.

⚠ CAUTION
The 80 mm ventilation clearances above and below the Control Unit must be observed. If these clearances are not observed, this can result in a thermal overload of the Control Unit.

Dimension drawing

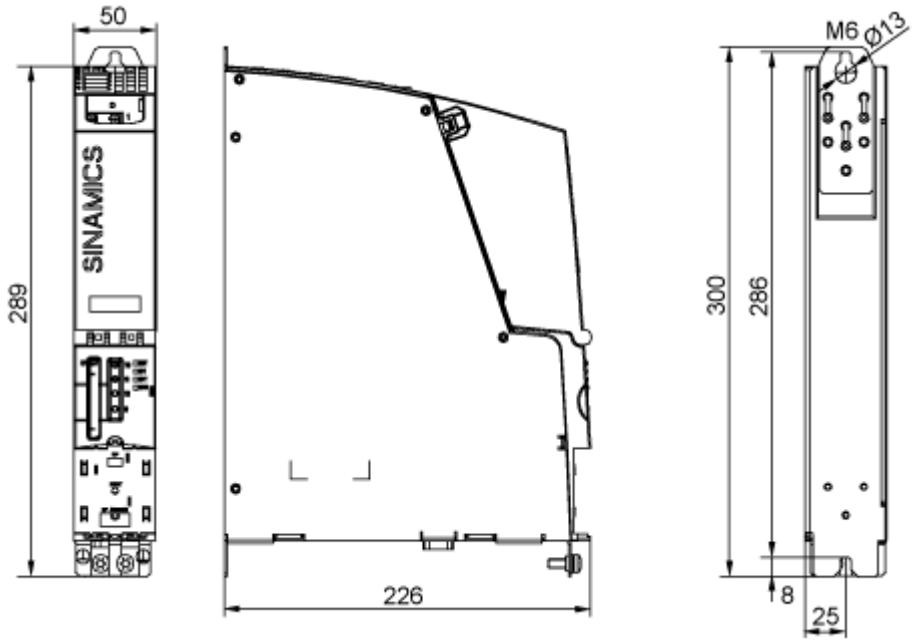


Figure 3-1 Dimension drawing of the CU320

Note

With frame sizes FX and GX, the CU320 is installed to the left of the Power Module. The required connection elements are supplied with the Power Module.

With frame sizes HX and JX, the CU320 is installed in the Power Module.

CU320: CompactFlash card

The CompactFlash card contains the control software and parameters.

Note

The CompactFlash card may only be inserted and removed when the Control Unit is disconnected from the power supply.

If it is inserted and removed when the power supply is connected, this can damage the CompactFlash card and/or result in data being lost.

3.6 TM31 Terminal Module

Description

The TM31 Terminal Module is a terminal extension board. It can be used to increase the number of digital inputs/outputs. Analog inputs and outputs are also available on the TM31.

⚠ CAUTION
The 80 mm ventilation clearances above and below the Terminal Module must be observed. If these clearances are not observed, this can result in a thermal overload of the Terminal Module.

Dimension drawing

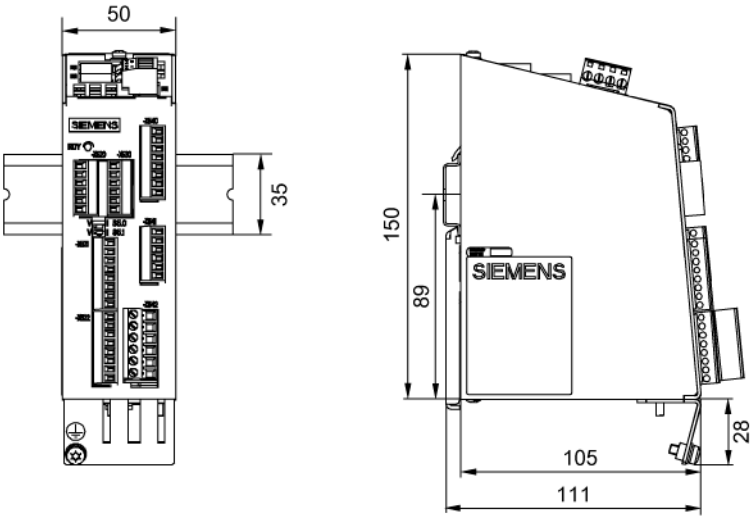


Figure 3-2 Dimension drawing of the TM31 Terminal Module

Note

The TM31 is installed near the Power Module on a mounting rail, which must be provided by the customer.

3.7 SMC30 Sensor Module

Description

The SMC30 Sensor Module is a module for evaluating encoder signals. TTL/HTL encoders (with or without open-circuit monitoring) can be connected to the SMC30. The motor temperature can also be detected using KTY84-1C130 or PTC thermistors.

⚠ CAUTION
The 80 mm ventilation clearances above and below the SMC30 Sensor Module must be observed. If these clearances are not observed, this can result in a thermal overload of the Sensor Module.

Dimension drawing

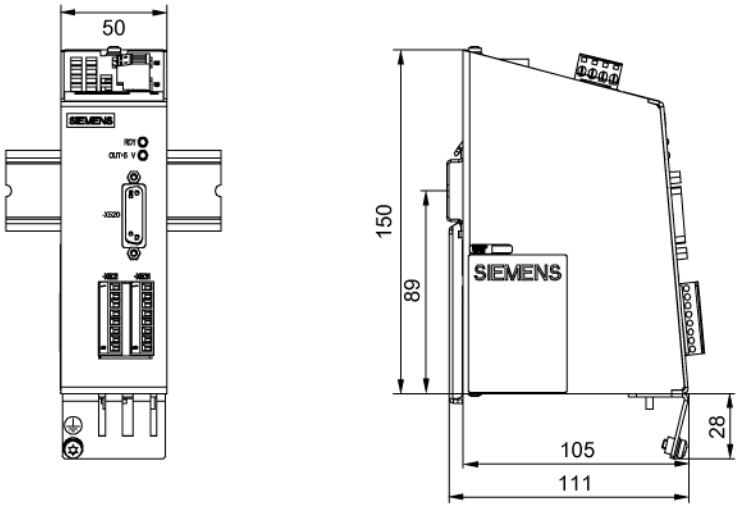


Figure 3-3 Dimension drawing of the SMC30 Sensor Module

Note

The SMC30 is installed near the Power Module on a mounting rail, which must be provided by the customer.

Electrical installation

4

4.1 Chapter content

This chapter provides information on the following:

- Establishing the electrical connections for the Power Module, the CU320 Control Unit, and the optional TM31 Terminal Module and SMC30 Sensor Module.
- Adjusting the fan voltage and the internal power supply in line with local conditions (supply voltage)
- The interfaces for the CU320 Control Unit, TM31 Terminal Module, and SMC30 Sensor Module.

4.2 Preparation

Required tools

To install the connections, you will require:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver, size 2
- Screwdriver Torx T20
- Screwdriver Torx T30

4.3 Important safety precautions

⚠ WARNING

The built-in units are operated with high voltages.
All connection procedures must be carried out when the cabinet is de-energized.
All work on the device must be carried out by trained personnel only.
Death, serious injury, or substantial material damage can result if these warnings are not taken into account.

Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running.
Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the cabinet should not be opened until a reasonable period of time has elapsed.

Reforming the DC link capacitors:
The storage period should not exceed two years. If the device is stored for more than two years, the DC link capacitors of the devices must be reformed during commissioning.
The reforming procedure is described in "Maintenance and Servicing”.

The operator is responsible for ensuring that the Power Module and other components are installed and connected in accordance with the recognized technical rules in the country of installation and applicable regional guidelines. Special attention should be paid to cable dimensioning, fuses, grounding, shutdown, disconnection, and overcurrent protection.

If an item of protective gear trips in a branch circuit, a leakage current may have been disconnected. To reduce the risk of fire or an electric shock, the current-conducting parts and other components in the cabinet unit should be inspected and damaged parts replaced. When an item of protective gear trips, the cause of the trip must be identified and rectified.

Note

The built-in units are equipped with shock-hazard protection in accordance with BGV A 3 to DIN 57 106, Part 100/VDE 0106, Part 100.

Note

On line systems with a grounded phase conductor and a line voltage > 600 V AC, line-side components should be installed to limit overvoltages to overvoltage category II in accordance with IEC 60664-1.

4.4 Introduction to EMC

What is meant by EMC?

Electromagnetic compatibility (EMC) describes the capability of an electrical device to function satisfactorily in an electromagnetic environment without itself causing interference unacceptable for other devices in the environment.

EMC therefore represents a quality feature for the

- Internal noise immunity: Resistance to internal electrical disturbances
- External noise immunity: resistance against external electromagnetic disturbances
- Noise emission level: environmental effects caused by electromagnetic emissions

To ensure that the cabinet unit functions satisfactorily in the system, the environment subject to interference must not be neglected. For this reason, special requirements exist regarding the structure and the EMC of the system.

Operational reliability and noise immunity

In order to achieve the greatest possible operational reliability and immunity to noise of a complete system (converter, automation, drive machines etc.), measures must be taken by the converter manufacturer and the user. Only when all of these measures have been taken are the satisfactory function of the converter and compliance with the legal requirements (89/336/EEC) ensured.

Noise emissions

Product standard EN 61800 – 3 outlines the EMC requirements for variable-speed drive systems. It specifies requirements for converters with operating voltages of less than 1000 V. Different environments and categories are defined depending on where the drive system is installed.

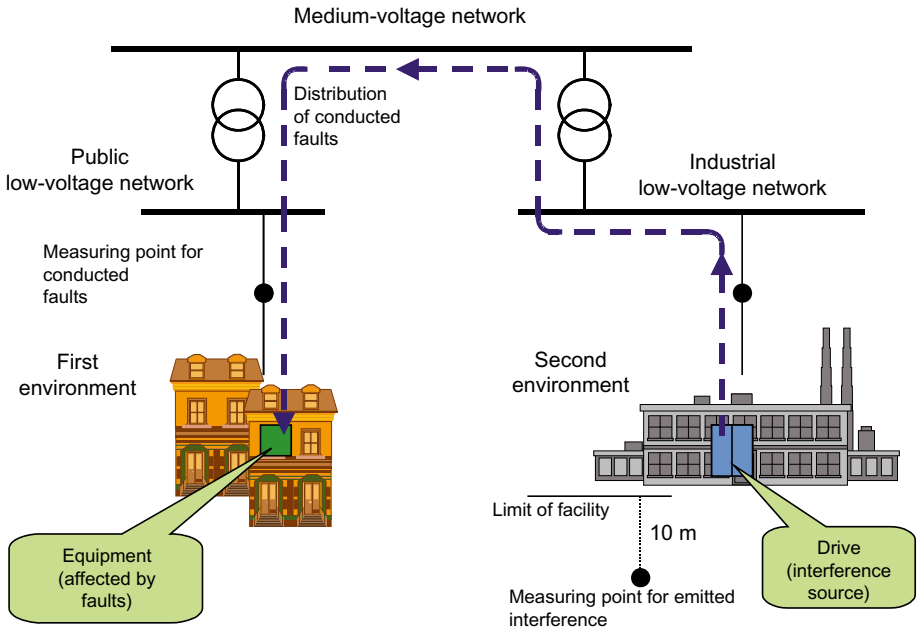


Figure 4-1 Definition of environments 1 and 2

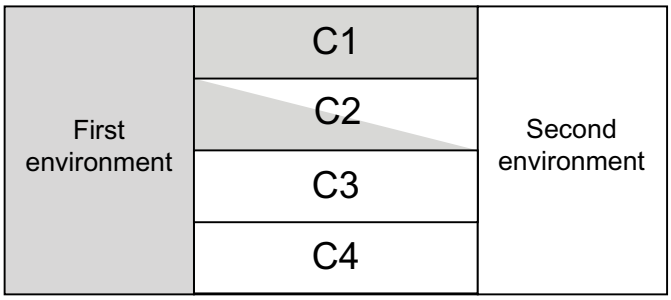


Figure 4-2 Definition of categories C1 to C4

Table 4-1 Definition of environments 1 and 2

Definition of environments 1 and 2	
Environment 1	Residential buildings or locations at which the drive system is connected to a public low-voltage supply network without a transformer.
Environment 2	Industrial locations supplied by a medium-voltage network via a separate transformer.

Table 4-2 Definition of categories C1 to C4

Definition of categories C1 to C4	
Category C1	Rated voltage <1000 V; unrestricted use in environment 1.
Category C2	Rated voltage for stationary drive systems <1000 V; for use in environment 2. For use in environment 1 only when sold and installed by skilled personnel.
Category C3	Rated voltage <1000 V; use in environment 2 only.
Category C4	Rated voltage ≥1000 V or for rated currents ≥ 400 A in complex systems in environment 2.

4.5 EMC-compliant design

The following section provides some basic information and guidelines that will help you comply with the EMC and CE guidelines.

cabinet assembly

- Connect painted or anodized metal components using toothed self-locking screws or remove the insulating layer.
- Use unpainted, de-oiled mounting plates.
- Establish a central connection between ground and the protective conductor system (ground).

Shield gaps

- Bridge shield gaps (at terminals, circuit-breakers, contactors, and so on) with minimum impedance and the greatest possible surface area.

Using large cross-sections

- Use underground and grounding cables with large cross-sections or, better still, with litz wires or flexible cables.

Laying the motor supply cable separately

- The distance between the motor supply cable and signal cable should be > 20 cm. Do not lay power cables and motor supply cables in parallel to each other.

Securing the potential to ground between modules with widely differing interference potential

- Lay an equalizing cable parallel to the control cable (the cable cross-section must be at least 16 mm²).
- If relays, contactors, and inductive or capacitive loads are connected, the switching relays or contactors must be provided with anti-interference elements.

Cable installation

- Cables that are subject to or sensitive to interference should be laid as far apart from each other as possible.
- Noise immunity increases when the cables are laid close to the ground potential. For this reason, you are advised to lay these cables in corners and at ground potential.
- Ground the spare cables on at least one end.
- Long cables should be shortened or laid in noise resistant areas to avoid additional connecting points.

- Conductors or cables that carry signals of different classes must cross at right angles, especially if they carry sensitive signals that are subject to interference.
  - Class 1:
    unshielded cables for ≤ 60 V DC
    unshielded cables for ≤ 25 V AC
    shielded analog signal cables
    shielded bus and data cables
    operator panel interfaces, incremental/absolute encoder lines
  - Class 2:
    unshielded cables for > 60 V DC and ≤ 230 V DC
    unshielded cables for > 25 V AC and ≤ 230 V AC
  - Class 3:
    unshielded cables for > 230 V AC/DC and ≤ 1000 V AC/DC

Shield connection

- Shields must not be used to conduct electricity. In other words, they must not simultaneously act as neutral or PE conductors.
- Apply the shield so that it covers the greatest possible surface area. You can use ground clamps, ground terminals, or ground screw connections.
- Avoid extending the shield to the grounding point using a wire (pigtail) because this will reduce the effectiveness of the shield by up to 90%.
- Attach the shield to a shield bar directly after the line inlet into the cabinet. Insulate the entire shielded cable and route the shield up to the device connection, but do not connect it again.

I/O interfacing

- Create a low-impedance ground connection for additional cabinets, system components, and distributed devices with the largest possible cross-section (at least 16 mm²).
- Ground unused lines at one end in the cabinet.
- Choose the greatest possible clearance between the power and signal cables (at least 20 cm). The greater the distance over which the cables are routed in parallel, the greater the clearance must be. If a sufficient clearance cannot be maintained, you must install additional shields.
- Avoid unnecessarily long cable loops.

Filtering cables

- Line supply cables and power supply cables for devices and modules may have to be filtered in the cabinet to reduce incoming or outgoing disturbances.
- To reduce emissions, the device is equipped with a radio interference suppression filter as standard (in accordance with the limit values defined in category C3). Optional filters, which are available on request, can be fitted for use in environment 1 (category C2).

4.6 Connection overview

Power Module, frame size FX

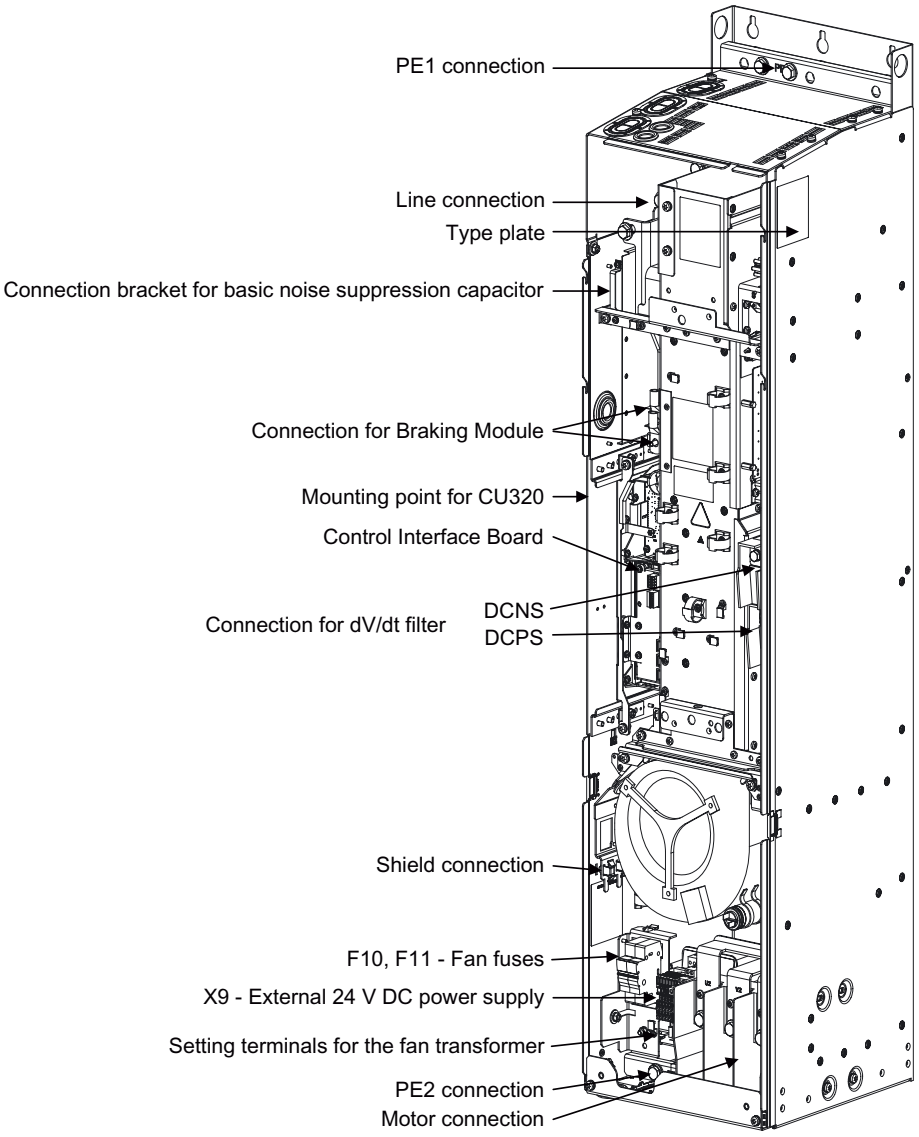


Figure 4-3 Connection overview of Power Module, frame size FX (without front cover)

Power Module (frame size GX)

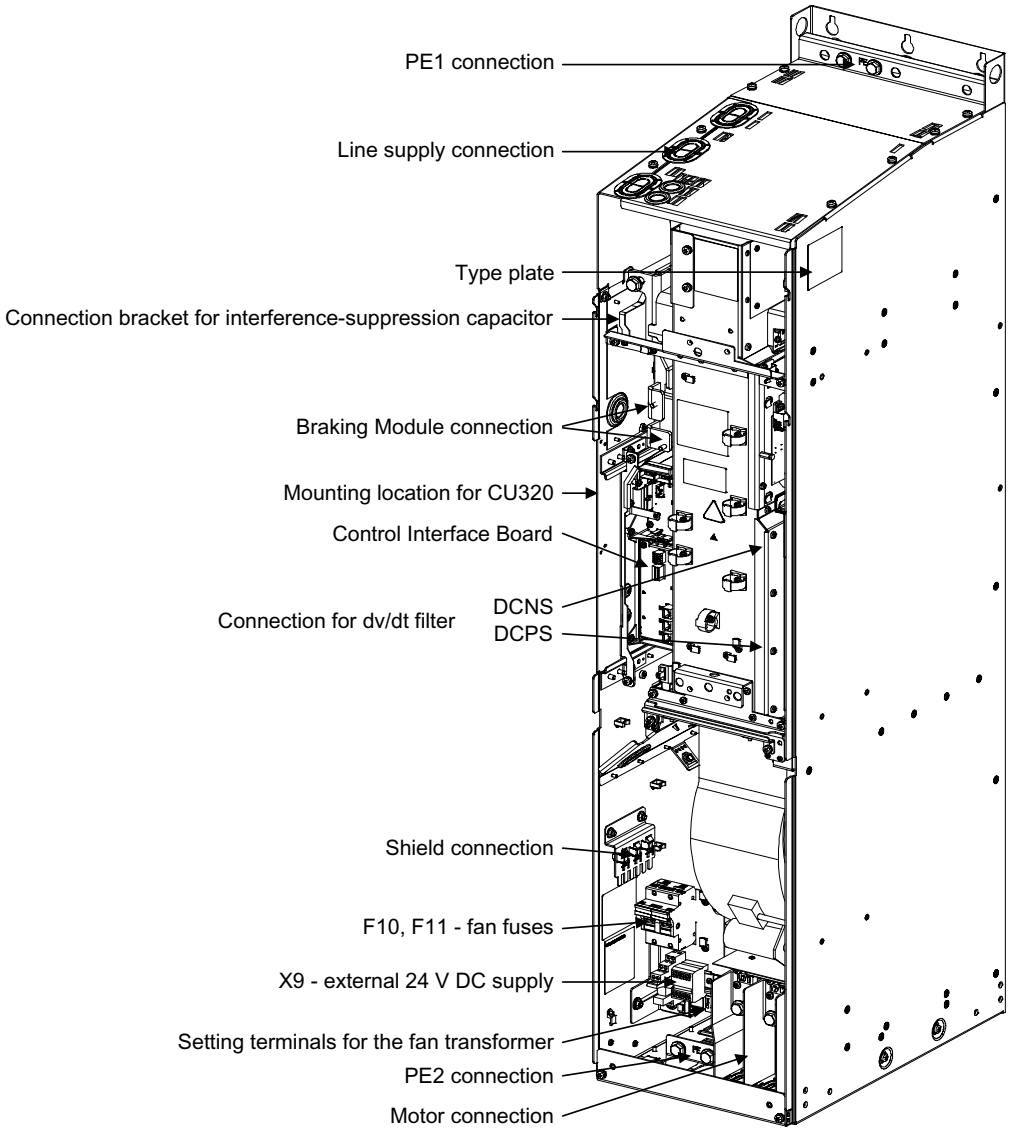


Figure 4-4 Connection overview of Power Module (frame size GX) (without front cover)

Power Module (frame size HX)

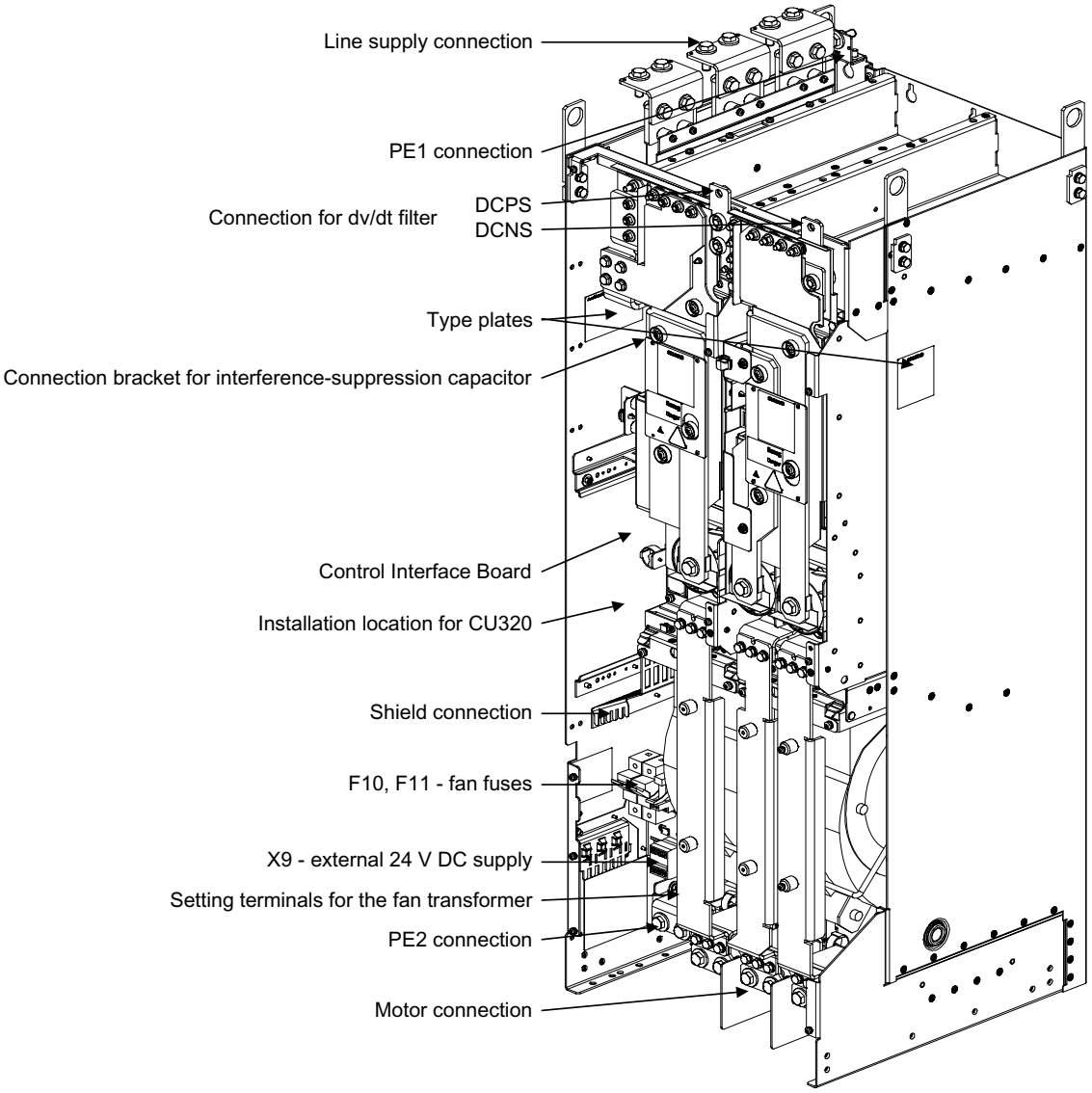


Figure 4-5 Connection overview of Power Module (frame size HX) (without front cover)

Power Module (frame size JX)

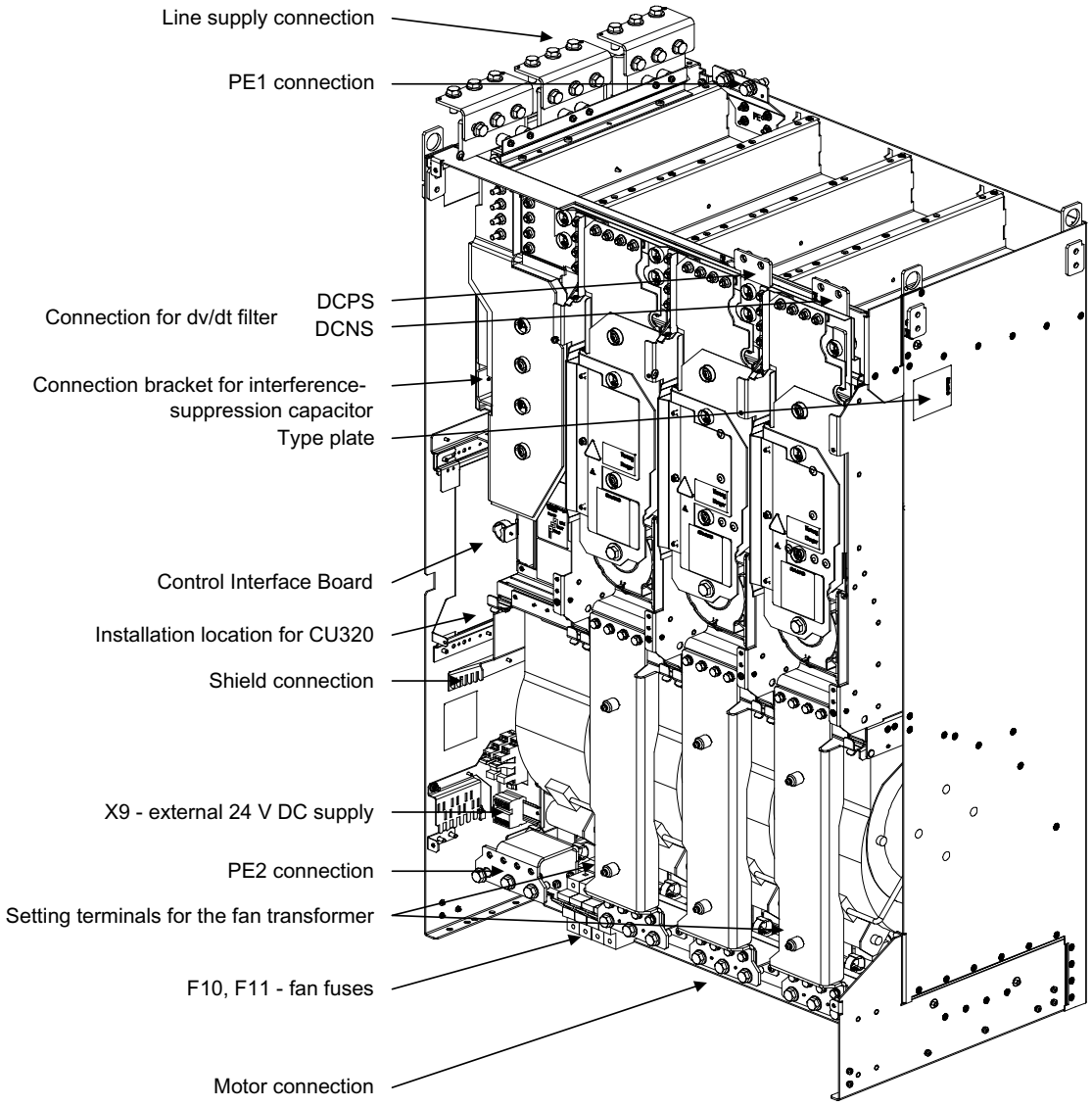


Figure 4-6 Connection overview of Power Module (frame size JX) (without front cover)

4.7 Power connections

⚠ WARNING

Swapping the input and output terminals can destroy the device!

Swapping or short-circuiting the DC link terminals can destroy the device!

The contactor and relay operating coils that are connected to the same supply network as the device or are located near the device must be connected to overvoltage limiters (e.g. RC elements).

The device must not be operated via a residual current operated device (DIN VDE 0160).

4.7.1 Connection cross-sections and cable lengths

Connection cross-sections

The connection cross-sections for the line connection, motor connection, and ground connection for your device are specified in the tables provided in the "Technical specifications" section.

Cable Lengths

The maximum permissible cable lengths are specified for standard cable types or cable types recommended by SIEMENS. Longer cables can only be used after consultation.

The listed cable length represents the actual distance between the converter and the motor, taking account factors such as parallel laying, current-carrying capacity, and the laying factor.

- Non-shielded cable (e.g., Protodur NYY): max. 450 m
- Shielded cable (e.g., Protodur NYCWY, Protoflex EMV 3 Plus): max. 300 m.

Note

The cable lengths specified are also valid if a motor reactor is in use.

Note

The PROTOFLEX-EMV-3 PLUS shielded cable recommended by Siemens is the protective conductor and comprises three symmetrically-arranged protective conductors. The individual protective conductors must each be provided with cable eyes and be connected to ground. The cable also has a concentric flexible braided copper shield. To comply with EN55011 regarding radio interference suppression, the shield must contact at both ends and with the greatest possible surface area.

On the motor side, cable glands that contact the shield with the greatest possible surface area are recommended for the terminal boxes.

4.7.2 Connecting the motor and power cables

Connecting the motor and power cables on the Power Module

1. If necessary, remove the covers or front covers in front of the connection panel for motor cables (terminals U2/T1, V2/T2, W2/T3; X2) and power cables (terminals U1/L1, V1/L2, W1/L3; X1).
2. Screw the protective earth (PE) into the appropriate terminal (with earth symbol) (50 Nm for M12) at the points provided in the cabinet.
3. Connect the motor cables to the terminals.
   Make sure that you connect the conductors in the correct sequence: U2/T1, V2/T2, W2/T3 and U1/L1, V1/L2, W1/L3.

CAUTION
Tighten the screws with the appropriate torque (50 Nm for M12), otherwise the terminal contacts could be destroyed by burning during operation.

Note

The motor ground must be fed back directly to the Power Module and connected.

Direction of motor rotation

With induction machines with a clockwise phase sequence (looking at the drive shaft), the motor must be connected to the Power Module as follows:

Table 4-3 Power Module and motor connection terminals

Power Module (connection terminals)	Motor (connection terminals)
U2/T1	U
V2/T2	V
W2/T3	W

In contrast to the connection for the clockwise phase sequence, two phases have to be reversed with a counter-clockwise phase sequence (looking at the drive shaft).

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Direction reversal").

With motors that can be operated in a star/delta configuration, the windings must be checked to ensure that they have been connected properly. Refer to the relevant documentation for the motor and note the required insulation voltage for operating the device.

4.7.3 DCPS, DCNS connection for a dV/dt filter with Voltage Peak Limiter

Table 4-4 DCPS, DCNS

Frame size	Connectable cross-section	Terminal screw
FX	1 x 70 mm²	M8
GX	1 x 70 mm²	M8
HX	1 x 185 mm²	M10
JX	2 x 185 mm²	M10

With frame sizes FX and GX, the connecting cables are routed down through the Power Module and out.

4.7.4 Adjusting the fan voltage

The power supply for the device fan (1 AC 230 V) in the Power Module is generated from the line supply using a transformer.

The transformer is fitted with primary taps so that it can be fine-tuned to the supply voltage. When delivered, the taps are always set to the highest level. With a low supply voltage, the appropriate transformer tap must be activated.

For the position of the setting terminals, see the "Connection overview" section.

Note

One transformer is installed in frame sizes FX, GX and HX; two transformers are installed in frame size JX. The two primary terminals on these devices must be set together.

The setting terminals must be connected to "0" and the supply voltage.

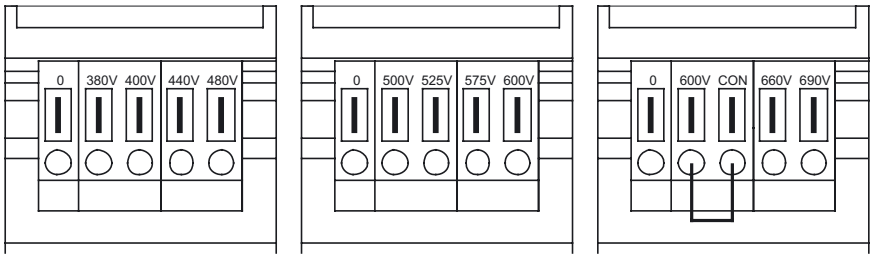


Figure 4-7 Setting terminals for the fan transformer (380 V - 480 V 3 AC/500 V - 600 V 3 AC/660V - 690 V 3 AC)

The supply voltage assignments for making the appropriate setting on the fan transformer are indicated in the following tables.

Note
With the 660 V – 690 V 3 AC fan transformer, a jumper is inserted between the "600 V" terminal and "CON" terminal. The "600V" and "CON" terminals are for internal use.

NOTICE

If the terminals are not reconnected to the actual supply voltage:

- The required cooling capacity cannot be provided because the fan rotates too slowly;
- The fan fuses may blow due to an overcurrent.

Table 4-5 Supply voltage assignments for setting the fan transformer (380 V – 480 V 3 AC)

Supply voltage	Fan transformer tap
380 V ± 10%	380 V
400 V ± 10%	400 V
440 V ± 10%	440 V
480 V ± 10%	480 V

Table 4-6 Supply voltage assignments for setting the fan transformer (500 V – 600 V 3 AC)

Supply voltage	Fan transformer tap
500 V ± 10%	500 V
525 V ± 10%	525 V
575 V ± 10%	575 V
600 V ± 10%	600 V

Table 4-7 Supply voltage assignments for setting the fan transformer (660 V – 690 V 3 AC)

Supply voltage	Fan transformer tap
660 V ± 10%	660 V
690 V ± 10%	690 V

4.7.5 Removing the connection bracket for the interference-suppression capacitor with operation from an ungrounded supply

If the built-in unit is operated from a non-grounded supply/IT system, the connection bracket for the noise suppression capacitor of the Power Module must be removed.

For the position of the connection bracket, see the "Connection overview" section.

⚠WARNING

Failing to remove the connection bracket for the noise suppression capacitor on a non-grounded system/IT system can cause significant damage to the built-in unit.

4.8 External 24 V DC supply

Description

An external 24 V DC supply is always recommended if communication and closed-loop control are to be independent of the supply system. An external auxiliary supply is particularly recommended for low-power lines susceptible to short-time voltage dips or power failures.

With an external supply independent of the main supply, warnings and fault messages may still be displayed on the operator panel and internal protection and monitoring devices if the main supply fails.

The power requirement is 4 A.

Connection

Connect the external 24 V DC supply to terminals 1 (P 24 V) and 2 (M_{ext}) of terminal block – X9 on the Power Module.

4.9 DRIVE-CLiQ wiring diagram

The diagram below shows the specifications for the DRIVE-CLiQ connections between the components.

CAUTION
These specifications for the DRIVE-CLiQ connections should be observed, otherwise faults may occur during commissioning via STARTER or the AOP30 operator panel.

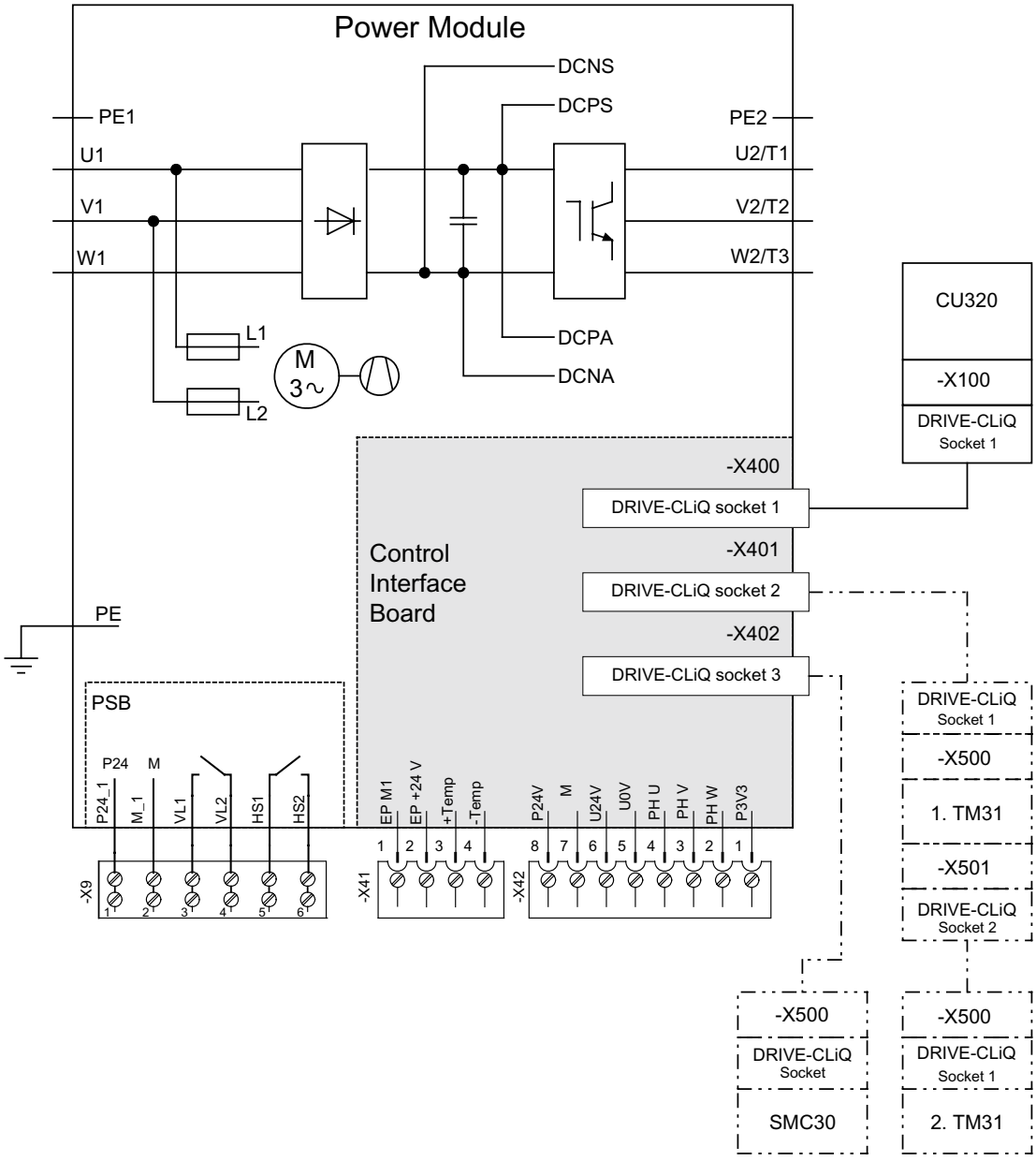


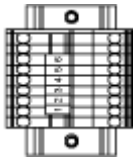
Figure 4-8 DRIVE-CLiQ wiring diagram

4.10 Signal connections

4.10.1 Power Module

X9: Terminal block

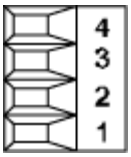
Table 4-8 Terminal block X9

	Terminal	Function	Technical specifications
	1	P24V	Voltage: 24 V DC (20.4 - 28.8 V) Current consumption: max. 4 A
	2	M	
	3	Reserved, do not use	
	4	Reserved, do not use	
	5	HS1	Line contactor control
	6	HS2	Line contactor control

Max. connectable cross-section: 1.5 mm² (AWG 14)

X41: EP terminals/temperature sensor connection

Table 4-9 Terminal block X41

	Terminal	Function	Technical specifications
	4	+ Temp	Temperature sensor connection KTY84–1C130 or PTC
	3	- Temp	
	2	EP +24 V (enable pulses)	Supply voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: 10 mA Signal propagation times: L → H 100 µs H → L: 1000 µs
	1	EP M1 (enable pulses)	

Max. connectable cross-section: 1.5 mm² (AWG 14)

NOTICE
The KTY temperature sensor must be connected with the correct polarity.

Note

The temperature sensor connection can be used for motors that are equipped with a KTY84-1C130 or PTC measurement sensor in the stator windings.

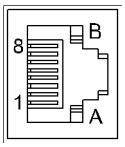
For operation, 24 V DC must be connected to terminal 2 and ground to terminal 1. Upon removal, pulse suppression is activated.

X42: Terminal block

Reserved, do not use!

X400 – X402: DRIVE-CLiQ interface

Table 4-10 DRIVE-CLiQ interface X400 – X402: Power Module

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	-
	5	Reserved, do not use	-
	6	RXN	Receive data -
	7	Reserved, do not use	-
	8	Reserved, do not use	-
	A	+ (24 V)	Power supply
	B	GND (0 V)	Electronic ground

4.10.2 Control Unit CU320

Connection overview

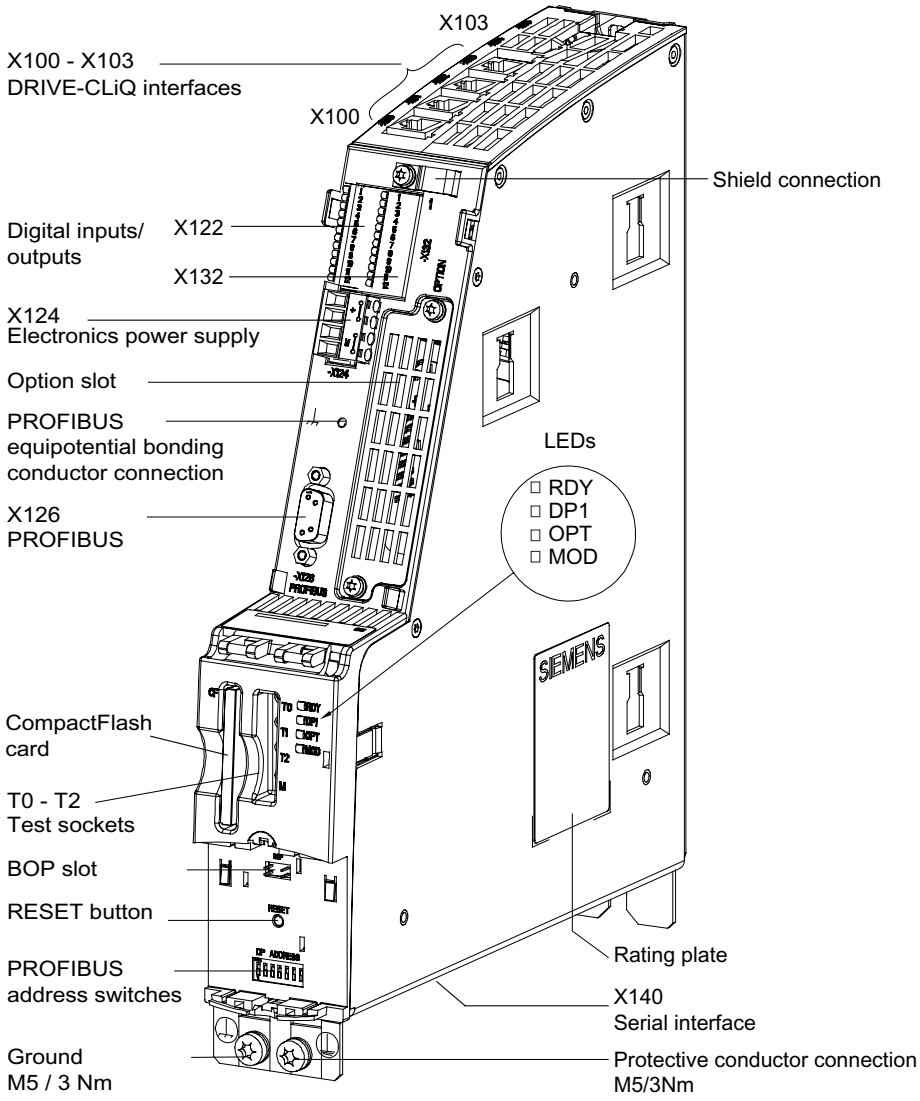


Figure 4-9 Overview of connections for CU320 Control Unit (without cover)

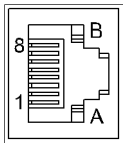
Note

The CompactFlash card may only be inserted and removed when the Control Unit is disconnected from the power supply.

If it is inserted and removed when the power supply is connected, this can result in data being lost.

X100 – X103: DRIVE-CLiQ interface

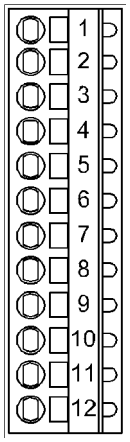
Table 4-11 DRIVE-CLiQ interface X100 - X103

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	GND (0 V)	Electronic ground

Blanking plate for DRIVE-CLiQ interface: Tyco, order no.: 969556-5

X122: Digital inputs/outputs

Table 4-12 Terminal block X122

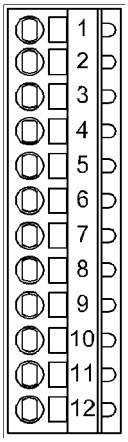
	Pin	Designation[1)]	Technical specifications
	1	DI 0	Voltage: -3 V to 30 V Typical power consumption: 10 mA at 24 V DC Isolation: reference potential is terminal M1 Level (incl. ripple) High level: 15 V to 30 V Low level: -3 V to 5 V Signal propagation times: L -> H approx. 50 µs H -> L: approx. 100 µs
	2	DI 1	
	3	DI 2	
	4	DI 3	
	5	M1	
	6	M	
	7	DI/DO 8	• As input: Voltage: -3 V to 30 V Typical power consumption: 10 mA at 24 V DC Level (incl. ripple) High level: 15 V to 30 V Low level: -3 V to 5 V Terminal numbers 8, 10, and 11 are "fast inputs" Signal propagation times for inputs/"fast inputs": L -> H: approx. 50 µs/5 µs H -> L: approx. 100 µs/50 µs • As output: Voltage: 24 V DC Max. load current per output: 500 mA, continued-short-circuit-proof
	8	DI/DO 9	
	9	M	
	10	DI/DO 10	
	11	DI/DO 11	
	12	M	

[1)] DI: digital input; DI/DO: Bidirectional digital input/output; M: Electronic ground M1: Ground reference

Max. connectable cross-section: 0.5 mm²

X132: Digital inputs/outputs

Table 4-13 Terminal block X132

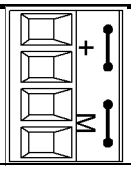
	Pin	Designation[1)]	Technical specifications
	1	DI 4	Voltage: -3 V to 30 V Typical power consumption: 10 mA at 24 V DC Isolation: The reference potential is terminal M2 Level (incl. ripple) High level: 15 V to 30 V Low level: -3 V to 5 V Signal propagation times: L -> H 50 µs H -> L: 100 µs
	2	DI 5	
	3	DI 6	
	4	DI 7	
	5	M2	
	6	M	
	7	DI/DO 12	• As input: Voltage: -3 V to 30 V Typical power consumption: 10 mA at 24 V DC Level (incl. ripple) High level: 15 V to 30 V Low level: -3 V to 5 V Terminal numbers 8, 10, and 11 are "fast inputs" Signal propagation times for inputs/"fast inputs": L -> H: approx. 50 µs/5 µs H -> L: approx. 100 µs/50 µs • As output: Voltage: 24 V DC Max. load current per output: 500 mA, continued-short-circuit-proof
	8	DI/DO 13	
	9	M	
	10	DI/DO 14	
	11	DI/DO 15	
	12	M	

[1)] DI: digital input; DI/DO: Bidirectional digital input/output; M: Electronic ground; M2: Ground reference

Max. connectable cross-section: 0.5 mm²

X124: Electronics power supply

Table 4-14 Terminal block X124

	Terminal	Function	Technical specifications
	+	Electronics power supply	Voltage: 24 V DC (20.4 V - 28.8 V) Current consumption: max. 0.8 A (without load) Max. current via jumper in connector: 20 A at 55 °C
	+	Electronics power supply	
	M	Electronic ground	
	M	Electronic ground	

Max. connectable cross-section: 2.5 mm² (AWG 12)

Note

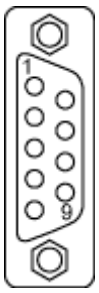
The two "+" and "M" terminals are jumpered in the connector. This ensures that the supply voltage is looped through.

The power can be supplied via terminals X41.1/2 on the Power Module.

X126: PROFIBUS connection

The PROFIBUS is connected by means of a 9-pin SUB D socket (X126). The connections are electrically isolated.

Table 4-15 PROFIBUS interface X126

	Pin	Signal name	Meaning	Range
	1	SHIELD	Ground connection	
	2	M24_SERV	Power supply for teleservice, ground	0 V
	3	RxD/TxD–P	Receive/transmit data P (B/B')	RS485
	4	CNTR–P	Control signal	TTL
	5	DGND	PROFIBUS data reference potential (C/C')	
	6	VP	Supply voltage plus	5 V + -10 %
	7	P24_SERV	Power supply for teleservice, + (24 V)	24 V (20.4 V - 28.8 V)
	8	RxD/TxD–N	Receive/transmit data N (A/A')	RS485
	9	-	Not assigned	

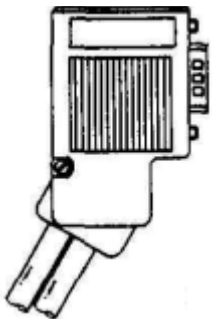
Note

The power supply for the teleservice terminals 2 and 7 withstands a load of 150 mA and is continued-short-circuit-proof.

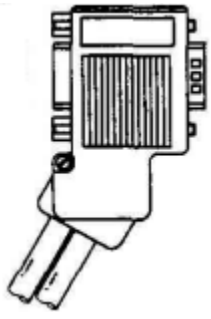
Connectors

The cables must be connected via PROFIBUS connectors as they contain the necessary terminating resistors.

The figure below shows suitable PROFIBUS connectors with/without a PG/PC connector.



PROFIBUS connector
without PG/PC connection
6ES7972-0BA41-0XA0



PROFIBUS connector
with PG/PC connection
6ES7972-0BB41-0XA0

Bus terminating resistor

The bus terminating resistor must be switched on or off depending on its position in the bus, otherwise the data will not be transmitted properly.

Principle: the terminating resistors must only be switched on at both ends of the bus line; the resistors must be switched off at all other connectors.

The cable shield must be connected at both ends over large-surface area contacts.

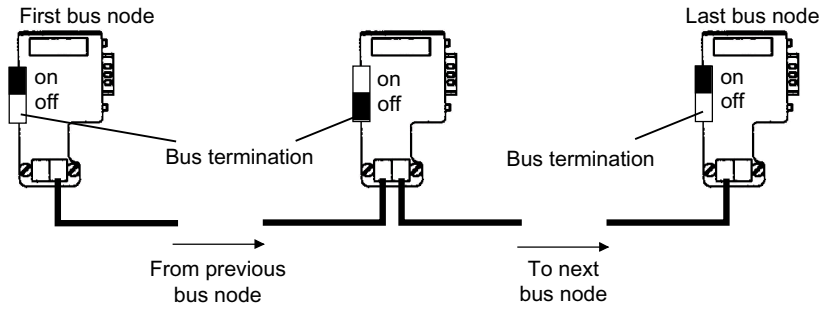


Figure 4-10 Posisition of the bus terminating resistors

PROFIBUS address switches

Table 4-16 PROFIBUS address switches

Switch	Significance	Technical specifications
S1	$2^0 = 1$	Significance 2^0 2^1 2^2 2^3 2^4 2^5 2^6 1 2 4 8 16 32 64 ON OFF S1 ··· S7 Example ON OFF 1 + 4 + 32 = 37
S2	$2^1 = 2$	
S3	$2^2 = 4$	
S4	$2^3 = 8$	
S5	$2^4 = 16$	
S6	$2^5 = 32$	
S7	$2^6 = 64$	

Note

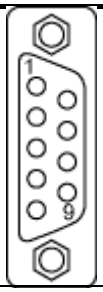
The factory settings are "ON" or "OFF" for all switches. With these two settings, the PROFIBUS address is set by parameterization.

The address switch is behind the blanking plate.

X140: serial interface (RS232)

The AOP30 operator panel for operating/parameterizing the device can be connected via the serial interface. The interface is located on the underside of the Control Unit. A standard cable can be used for connecting the AOP30 operator panel to the RS232 interface.

Table 4-17 Serial interface (RS232) X140

	Pin	Designation	Technical specifications
	2	RxD	Receive data
	3	TxD	Transmit data
	5	Ground	Ground reference
Connector type:		9-pin SUB D socket	

T0, T1, T2: Measuring sockets

Table 4-18 Measuring sockets T0, T1, T2

Socket	Function	Technical specifications
T0	Measuring socket 0	Voltage: 0 V to 5 V Resolution: 8 bits Load current: max. 3 mA Continued-short-circuit-proof The reference potential is terminal M
T1	Measuring socket 1	
T2	Measuring socket 2	
M	Ground	

Measuring sockets for bunch pin plugs d: 2 mm

Note

The measuring sockets are only used as an aid during commissioning.

Slot for the CompactFlash card

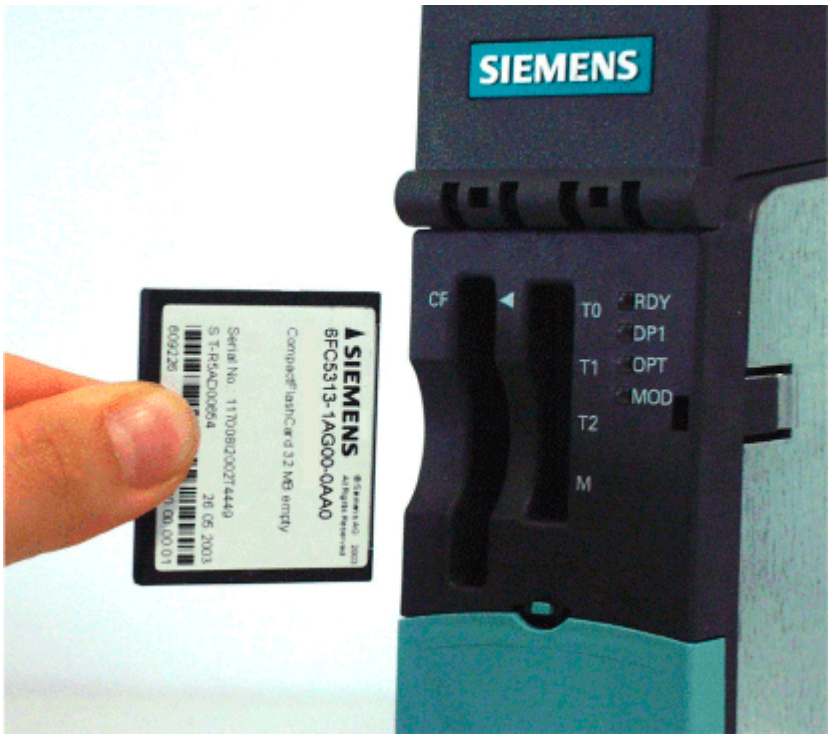


Figure 4-11 CompactFlash card slot

CAUTION
The CompactFlash card may only be inserted as shown in the diagram (arrow top right). The CompactFlash card may only be inserted or removed when the Control Unit is disconnected from the power supply. When returning a defective unit, remove the CompactFlash card and keep it for insertion in the replacement unit. If you do not do this, all the data on the CompactFlash card will be lost (parameters, software license, etc.).

Wiring diagram

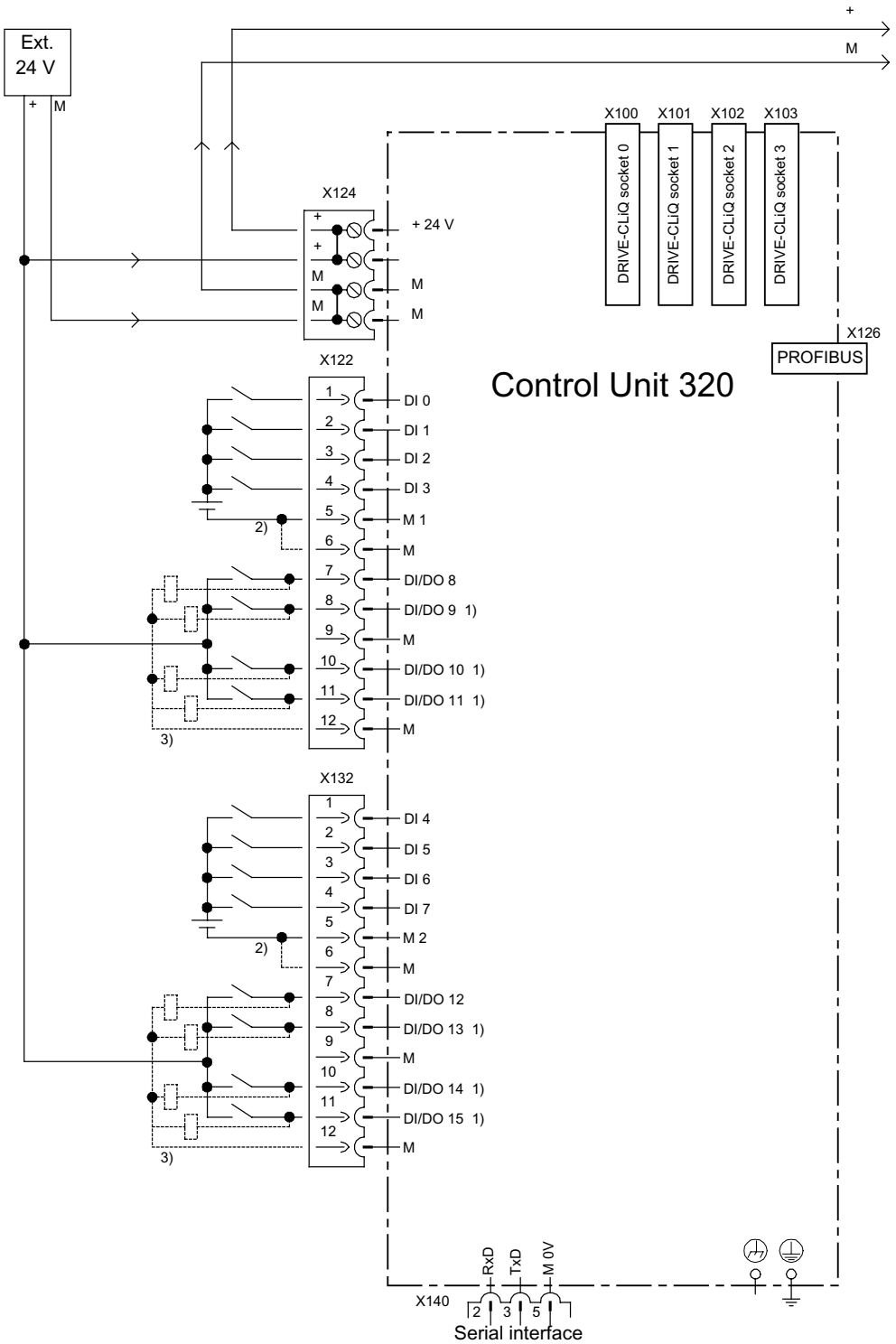


Figure 4-12 Wiring diagram of the CU320

4.10.3 TM31 Terminal Module

Description

The TM31 Terminal Module (TM31) is a terminal extension board. It can be used to increase the number of available digital/analog inputs/outputs within a drive system.

Connection overview

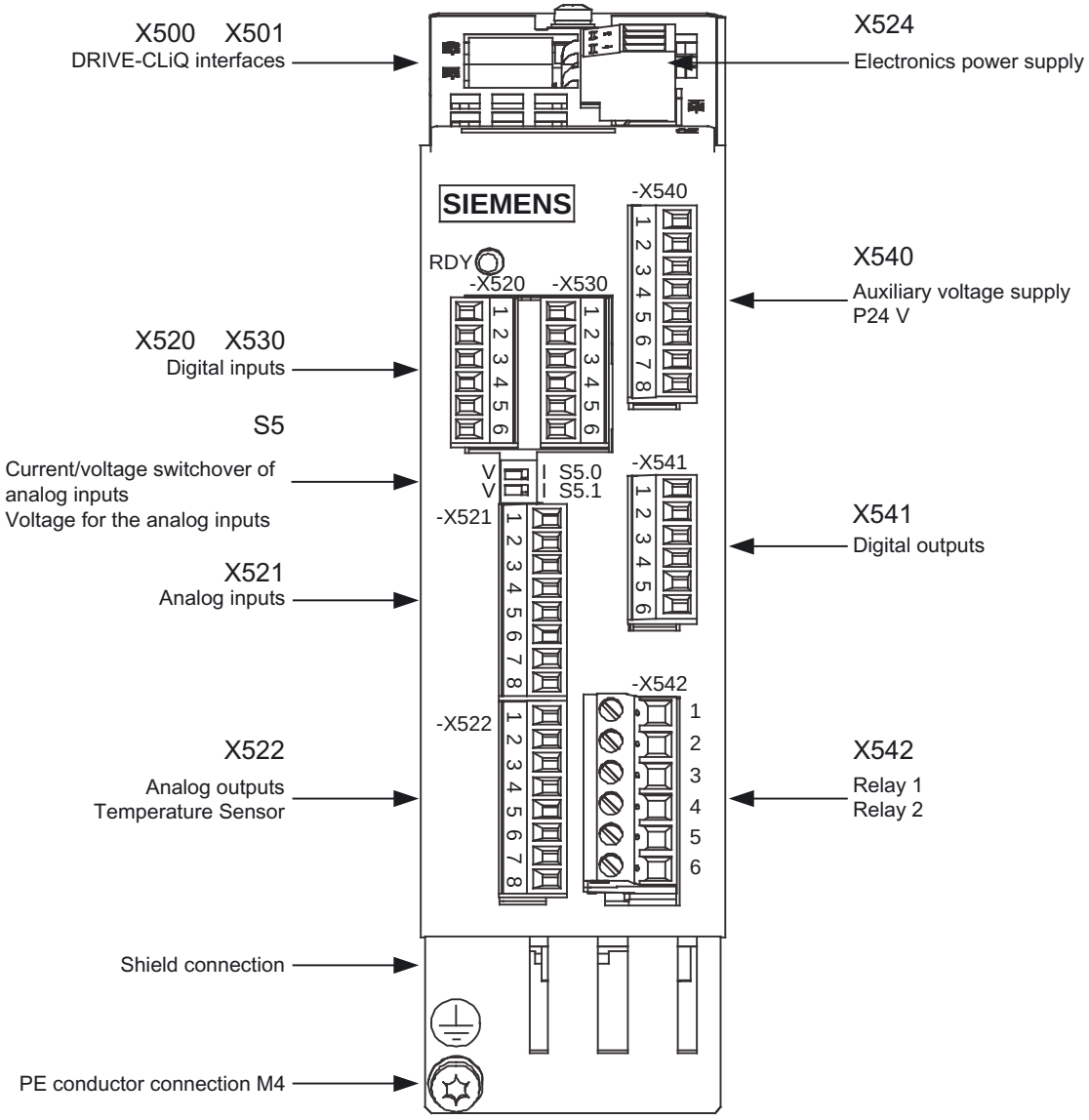


Figure 4-13 TM31 Terminal Module

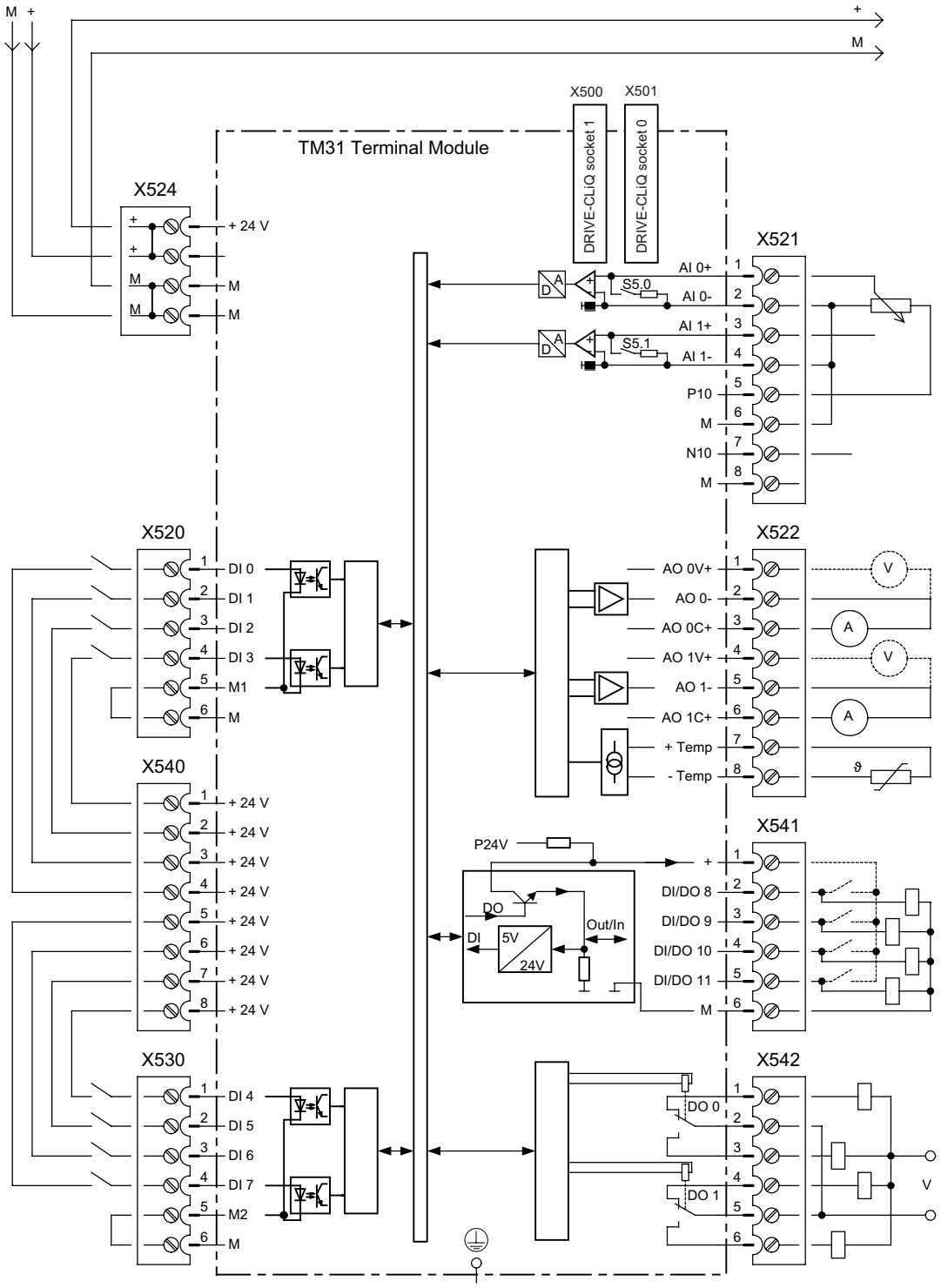


Figure 4-14 Connection overview of TM31 Terminal Module

Note

The diagram of the Terminal Module shows the factory setting. The digital inputs (terminals -X520 and -X530) in the example are powered by the internal 24 V supply of the Terminal Module (terminal -X540).

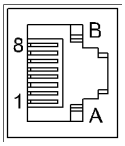
The two groups of digital inputs (optocoupler inputs) have a common reference potential (ground reference M1 or M2). To close the circuit when the internal 24 V supply is used, the ground references M1 / M2 must be connected to internal ground (M).

If the power is not supplied from the internal 24 V supply (terminal –X540), the jumper between ground M1 and M or M2 and M must be removed and M1 or M2 must be connected to the ground of the external 24 V DC supply.

If you do not do this, this can result in potential rounding.

X500, X501: DRIVE-CLiQ interface

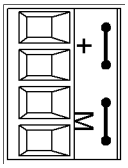
Table 4-19 DRIVE-CLiQ interface X500 and X501

	Pin	Signal name	Technical specifications
	1	TXP	Transmit data +
	2	TXN	Transmit data -
	3	RXP	Receive data +
	4	Reserved, do not use	
	5	Reserved, do not use	
	6	RXN	Receive data -
	7	Reserved, do not use	
	8	Reserved, do not use	
	A	+ (24 V)	Power supply
	B	GND (0 V)	Electronic ground

Blanking plate for DRIVE-CLiQ interface: Tyco, order no.: 969556-5

X524: Electronics power supply

Table 4-20 Terminal block X524

	Terminal	Function	Technical specifications
	+	Electronics power supply	Voltage: 24 V DC (20.4 V - 28.8 V)
	+	Not used	Current consumption: max. 0.5 A
	M	Electronic ground	Max. current via jumper in connector: 20 A at 55°C
	M	Electronic ground	

Max. connectable cross-section: 2.5 mm² (AWG 12)

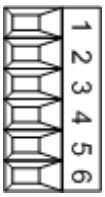
Note

The two "+" and "M" terminals are jumpered in the connector and not in the unit.
This ensures that the supply voltage is looped through.

The power can be supplied via terminals X41:1/2 on the Power Module.

X520: 4 digital inputs

Table 4-21 Terminal block X520

	Terminal	Designation[1)]	Technical specifications
	1	DI 0	Voltage: - 3 V to 30 V
	2	DI 1	Current input (typical): 10 mA up to 24 V
	3	DI 2	With electrical isolation: reference potential is terminal M1
	4	DI 3	Level:
	5	M1	- High signal level: 15 V to 30 V
	6	M	- Low signal level: -3 V to 5 V

[1)] DI: digital input; M1: ground reference; M: Electronics ground

Max. connectable cross-section: 1,5 mm² (AWG 14)

Note

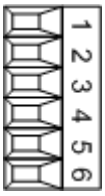
An open input is interpreted as "low".

To enable the digital inputs to function, terminal M1 must be connected. The following options are available:

1. The provided ground reference of the digital inputs, or
2. a jumper to terminal M (notice: this removes isolation for these digital inputs).

X530: 4 digital inputs

Table 4-22 Terminal block X530

	Terminal	Designation[1)]	Technical specifications
	1	DI 4	Voltage: - 3 V to 30 V
	2	DI 5	Current input (typical): 10 mA up to 24 V
	3	DI 6	With electrical isolation: The reference potential is terminal M2
	4	DI 7	Level:
	5	M2	- High signal level: 15 V to 30 V
	6	M	- Low signal level: -3 V to 5 V

[1)] DI: digital input; M2: ground reference; M: Electronics ground

Max. connectable cross-section: 1.5 mm² (AWG 14)

Note

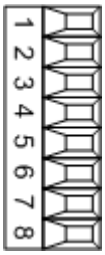
An open input is interpreted as "low".

To enable the digital inputs to work, terminal M2 must be connected. The following options are available:

1. The provided ground reference of the digital inputs, or
2. a jumper to terminal M (notice: this removes isolation for these digital inputs).

X521: 2 analog inputs (differential inputs)

Table 4-23 Terminal block X521

	Terminal	Designation[1)]	Technical specifications
	1	AI 0+	-10 V - +10 V, Ri = 70 kΩ (factory setting)
	2	AI 0-	+4 mA - +20 mA
	3	AI 1+	-20 mA - +20 mA, Ri = 250 Ω
	4	AI 1-	0 mA - +20 mA
	5	P10	+10 V ± 1%, Imax 5 mA
	6	M	Reference potential for AI 0
	7	N10	-10 V ± 1%, Imax 5 mA
	8	M	Reference potential for AI 1

[1)] AI: analog input; P10/N10: auxiliary voltage, M: Ground reference

Max. connectable cross-section: 1.5 mm² (AWG 14)

CAUTION
The input current of the analog inputs must not exceed 35 mA when current measurements are performed.

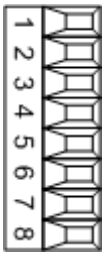
S5: selector for voltage/current AI0, AI1

Table 4-24 Selector for voltage/current S5

Switch	Function	Technical specifications
S5.0	Selector voltage/current AI0	Voltage Current
S5.1	Selector voltage/current AI1	

X522: 2 analog outputs, temperature sensor connection

Table 4-25 Terminal block X522

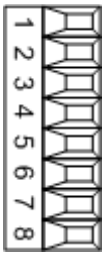
	Terminal	Designation[1)]	Technical specifications
	1	AO 0 V+	-10 V - +10 V +4 mA - +20 mA -20 mA - +20 mA 0 mA - +20 mA
	2	AO 0 ref.	
	3	AO 0 A+	
	4	AO 1 V+	
	5	AO 1 ref.	
	6	AO 1 A+	
	7	KTY+	KTY84: 0...200°C PTC: R_{cold} ≤ 1,5 kΩ
	8	KTY-	

[1)] AO: analog output; KTY: temperature sensor connection

Max. connectable cross-section: 1,5 mm² (AWG 14)

X 540: Joint auxiliary voltage for the digital inputs

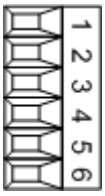
Table 4-26 Terminal block X540

	Terminal	Designation	Technical specifications
	1	P24	24 V DC Imax = 150 mA (total of all P24 terminals) Continued-short-circuit-proof
	2	P24	
	3	P24	
	4	P24	
	5	P24	
	6	P24	
	7	P24	
	8	P24	

Max. connectable cross-section: 1.5 mm² (AWG 14)

X541: 4 non-floating digital inputs/outputs

Table 4-27 Terminal block X541

	Terminal	Designation[1)]	Technical specifications
	1	P24	**As input:**
	2	DI/DO 8	Voltage: -3 V to 30 V
	3	DI/DO 9	Current input (typical): 10 mA at 24 V DC
	4	DI/DO 10	**As output:**
	5	DI/DO 11	The aggregate current of the four digital outputs is software limited: • at p4046 = 0: 100 mA (factory setting) • at p4046 = 1: 1 A
	6	M	Continued-short-circuit-proof

[1)] DI/DO: Digital input/output: M: Electronic ground

Max. connectable cross-section: 1.5 mm^2 (AWG 14)

Note

An open input is interpreted as "low".

When externally-generated 24 V DC signals are connected, the ground must also be connected.

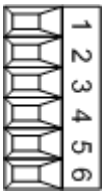
CAUTION

The aggregate current set via p4046 must be provided via the external electronic power supply.

Due to the limitation of the aggregate of the output currents an over-current can cause a short circuit on an output terminal or even intrusion of the signal of a different terminal.

X542: 2 relay outputs (two-way contact)

Table 4-28 Terminal block X542

	Terminal	Designation[1)]	Technical specifications
	1	DO 0.NC	Max. load current: 8 A
	2	DO 0.COM	Max. switching voltage: 250 V AC, 30 V DC
	3	DO 0.NO	Max. switching voltage: - at 250 V AC: 2000 VA - at 30 V DC: 240 W (ohmic load)
	4	DO 1.NC	
	5	DO 1.COM	
	6	DO 1.NO	Required minimum load: 20 mA

[1)] NO: normally-open contact, NC: normally-closed contact, COM: mid-position contact

Max. connectable cross-section: 2.5 mm² (AWG 12)

Note

If 230 V AC is applied to the relay outputs, the Terminal Module must also be grounded via a 6 mm² protective conductor.

4.10.4 SMC30 Sensor Module for determining the actual motor speed

4.10.4.1 Description

The SMC30 Sensor Module is used for determining the actual motor speed. The signals emitted by the rotary pulse encoder are converted here and made available via the DRIVE-CLiQ interface of the closed-loop control for evaluation purposes.

The following encoders can be connected to the SMC30 Sensor Module:

- TTL encoder
- HTL encoder
- KTY or PTC temperature sensor

Table 4-29 Connectable sensors with supply voltage

Sensor type	Remote sense	X520 (D-Sub)	X521 (terminal)	X531 (terminal)	Open-circuit monitoring
HTL bipolar 24 V	No	No	Yes	Yes	No
HTL unipolar 24 V	No	No	Yes	Yes	No
TTL bipolar 24 V	No	Yes	Yes	Yes	Yes
TTL bipolar 5 V	To X520	Yes	Yes	Yes	Yes
TTL unipolar	No	No	No	No	No

Table 4-30 Maximum signal cable lengths

Sensor type	Maximum signal cable length in m
TTL	100
HTL unipolar	100 m
HTL bipolar	300 m

Note

For HTL encoders, in order to reduce the effect of interference, a bipolar connection is recommended.

For encoders with a 5 V supply at X521/X531, the cable length is dependent on the encoder current (this applies cable cross-sections of 0.5 mm²):

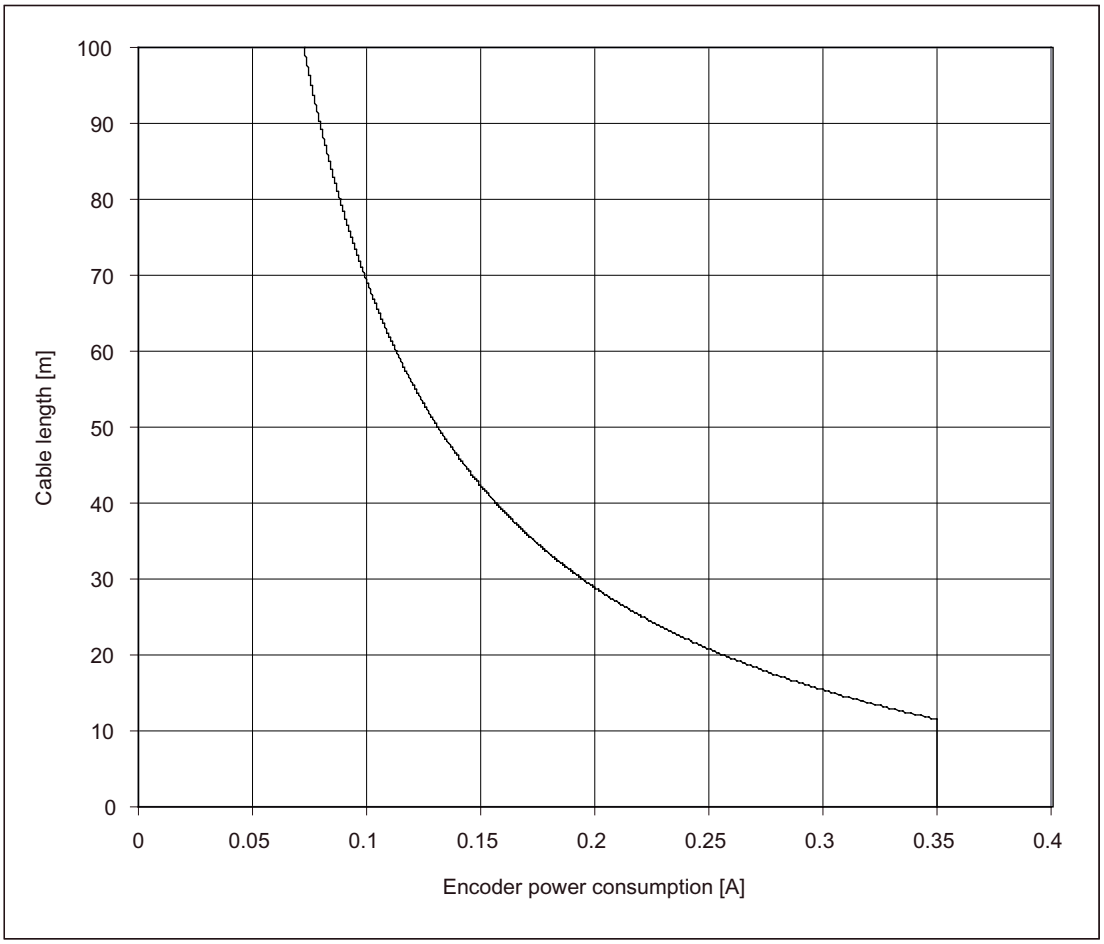


Figure 4-15 Signal cable length as a function of the sensor current consumption

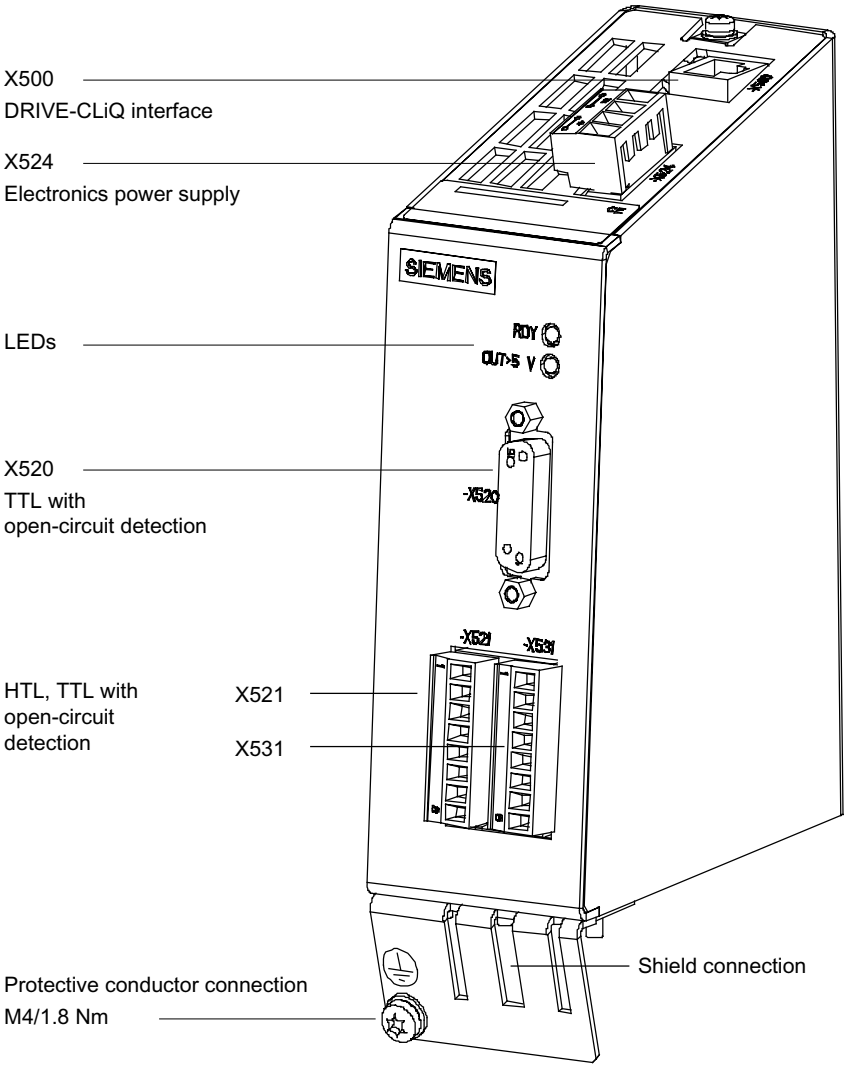
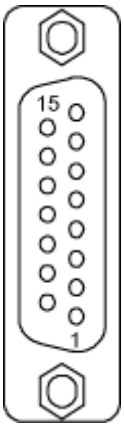


Figure 4-16 SMC30 Sensor Module

4.10.4.2 Connection

X520: Encoder connection 1 for TTL encoder with open-circuit monitoring

Table 4-31 Encoder connection X520

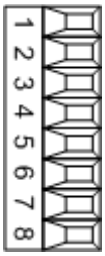
	Pin	Signal name	Technical specifications
	1	Reserved, do not use	
	2	Reserved, do not use	
	3	Reserved, do not use	
	4	P_Encoder 5 V / 24 V	Encoder power supply
	5	P_Encoder 5 V / 24 V	Encoder supply
	6	P_Sense	Sense input encoder power supply
	7	M_Encoder (M)	Ground for encoder power supply
	8	Reserved, do not use	
	9	M_Sense	Ground sense input
	10	R	Reference signal R
	11	R*	Inverted reference signal R
	12	B*	Inverted incremental signal B
	13	B	Incremental signal B
	14	A*	Inverted incremental signal A
	15	A	Incremental signal A

Connector type: 15-pin socket

CAUTION
The encoder power supply can be parameterized to 5 V or 24 V. The encoder may be destroyed if you enter the wrong parameter.

X521 / X531: Encoder connection 2 for HTL/TTL encoder with open-circuit monitoring

Table 4-32 Encoder connection X521

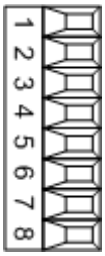
	Terminal	Signal name	Technical specifications
	1	A	Incremental signal A
	2	A*	Inverted incremental signal A
	3	B	Incremental signal B
	4	B*	Inverted incremental signal B
	5	R	Reference signal R
	6	R*	Inverted reference signal R
	7	CTRL	Control signal
	8	M	Ground via inductivity

Max. connectable cross-section: 1.5 mm² (AWG 14)

Note

When unipolar HTL encoders are used, A*, B*, and R* on the terminal block must be jumpered with M_Encoder (X531).

Table 4-33 Encoder connection X531

	Terminal	Signal name	Technical specifications
	1	P_Encoder 5 V / 24 V	Encoder supply
	2	M_Encoder	Ground for encoder power supply
	3	-Temp	Temperature sensor connection KTY84-1C130/PTC
	4	+Temp	
	5	Reserved, do not use	
	6	Reserved, do not use	
	7	Reserved, do not use	
	8	Reserved, do not use	

Max. connectable cross-section: 1.5 mm² (AWG 14)

Note

Note that when the encoder is connected via terminals, the cable shield must be applied to the module.

NOTICE
The KTY temperature sensor must be connected with the correct polarity.

4.10.4.3 SMC30 Sensor Module for determining the actual motor speed

Connection example 1: HTL encoder, bipolar, without zero marker -> p0405 = 9 (hex)

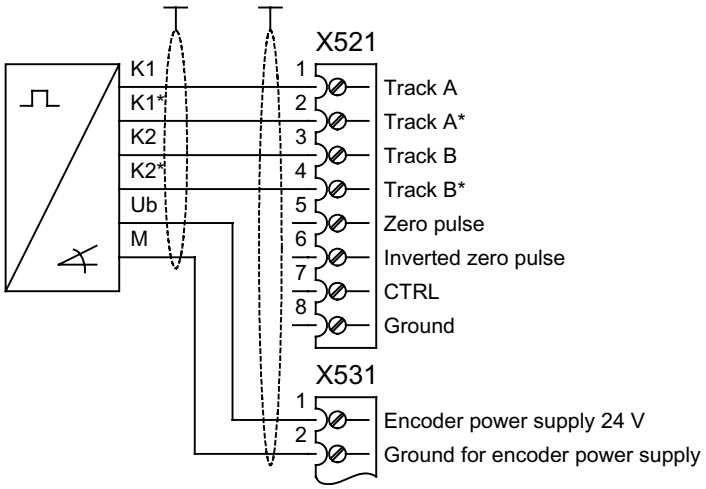


Figure 4-17 Connection example 1: HTL encoder, bipolar, without zero marker

Connection example 2: TTL encoder, unipolar, without zero marker -> p0405 = A (hex)

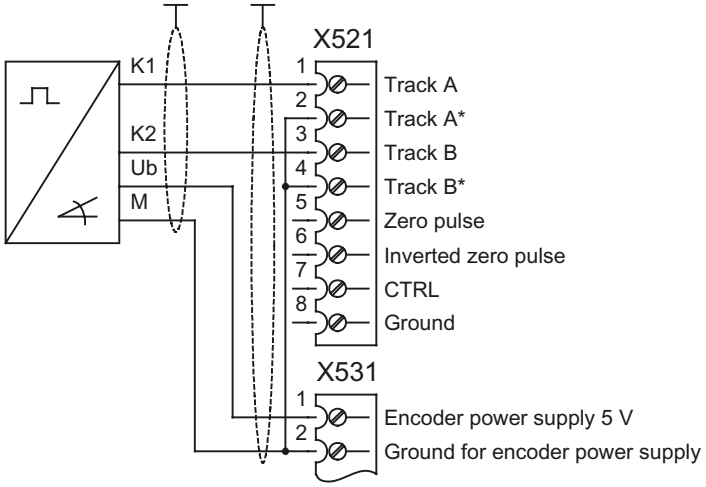


Figure 4-18 Connection example 2: TTL encoder, unipolar, without zero marker

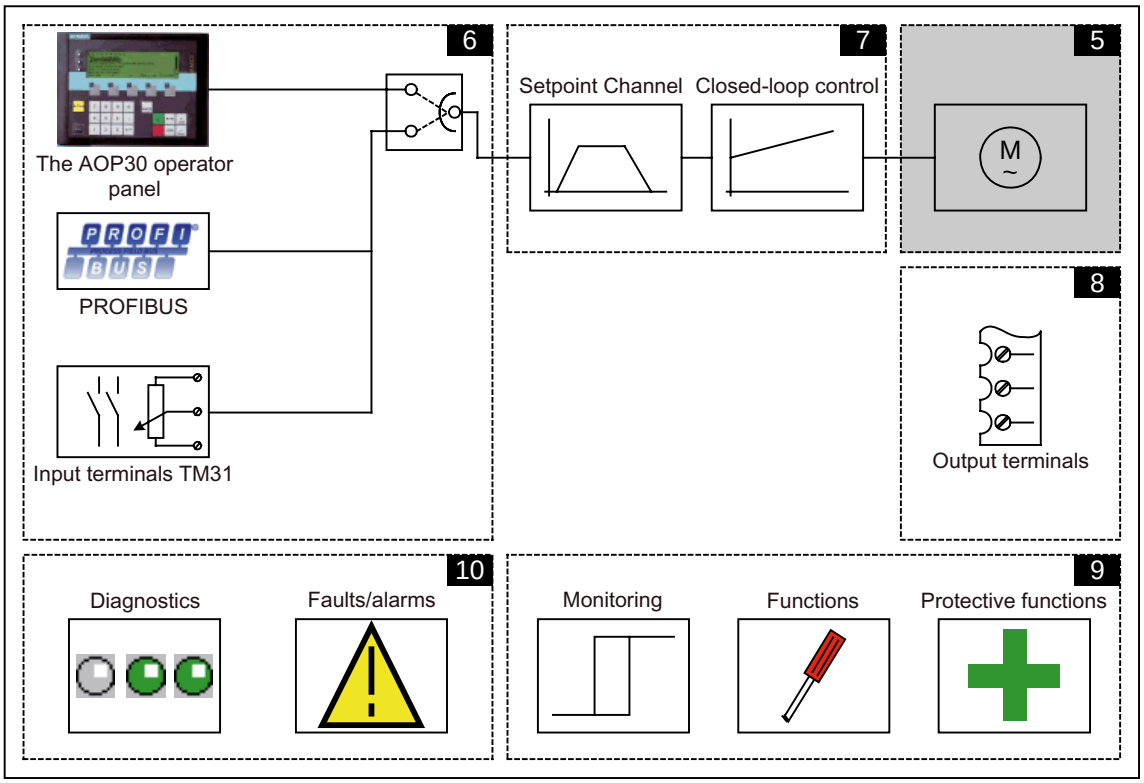
Commissioning

5

5.1 Chapter content

This chapter provides information on the following:

- Initial commissioning of the chassis unit (initialization)
  - Entering the motor data (drive commissioning)
  - Entering the most important parameters (basic commissioning), concluding with motor identification
- Data backup
- Parameter reset to factory settings



5.2 STARTER commissioning tool

Description

You can use the STARTER commissioning tool to configure and commission SINAMICS drives and drive systems. The drive can be configured using the STARTER drive configuration Wizard.

Note

This chapter shows you how to carry out commissioning using STARTER. STARTER features a comprehensive online help function, which provides detailed explanations of all the processes and available system settings.
For this reason, this chapter only describes the individual commissioning steps.

Prerequisites for installing STARTER

Hardware requirements:

- PG or PC with:
- Windows 2000: Pentium II 400 MHz, 256 MB RAM (512 MB recommended)
- Windows XP: Pentium III 500 MHz, 256 MB RAM (512 MB recommended)
- 1024 x 768 pixel screen resolution

Software requirements:

- Either Windows 2000 SP3 or SP4
- or Windows XP SP1 or SP2
- or Windows Server 2003 SP1
- and Internet Explorer V6.0

5.2.1 Installing STARTER

STARTER is installed using the "setup" file on the CD supplied. When you double-click the "Setup" file, the installation Wizard guides you through the process of installing STARTER.

5.2.2 The STARTER user interface

STARTER features four operating areas:

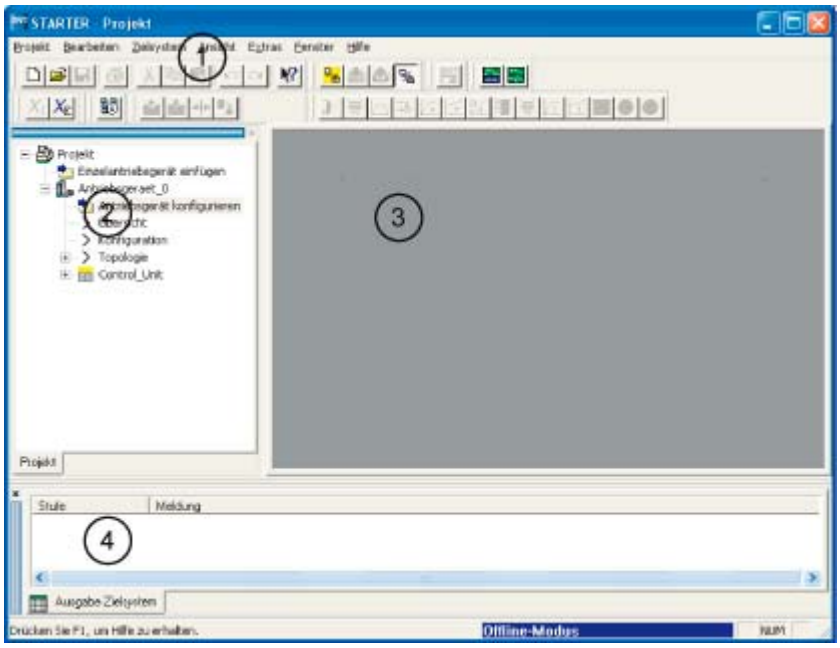


Figure 5-1 STARTER operating areas

Operating area	Explanation
1: Toolbars	In this area, you can access frequently used functions via the icons.
2: Project navigator	The elements and projects available in the project are displayed here.
3: Working area	In this area, you can change the settings for the drive units.
4: Detail view	Detailed information about faults and alarms, for example, is displayed this area.

5.3 Procedure for commissioning via STARTER

Basic procedure using STARTER

STARTER uses a sequence of dialog screens for entering the required drive unit data.

NOTICE
These dialog screens contain default settings, which you may have to change according to your application and configuration. This is intentional because By taking time to consider what configuration data you enter, you can prevent inconsistencies between the project data and drive unit data (identifiable in online mode).

5.3.1 Creating a project

Click the STARTER icon on your desktop or choose the following menu path in the Windows start menu to call up STARTER: Start > Simatic > STEP 7 > STARTER.

The first time you run the software, the main screen (shown below) appears with the following windows:

- STARTER Getting Started Drive Commissioning
- STARTER Project Wizard

The commissioning steps are listed below in numerical order.

Accessing the STARTER project Wizard

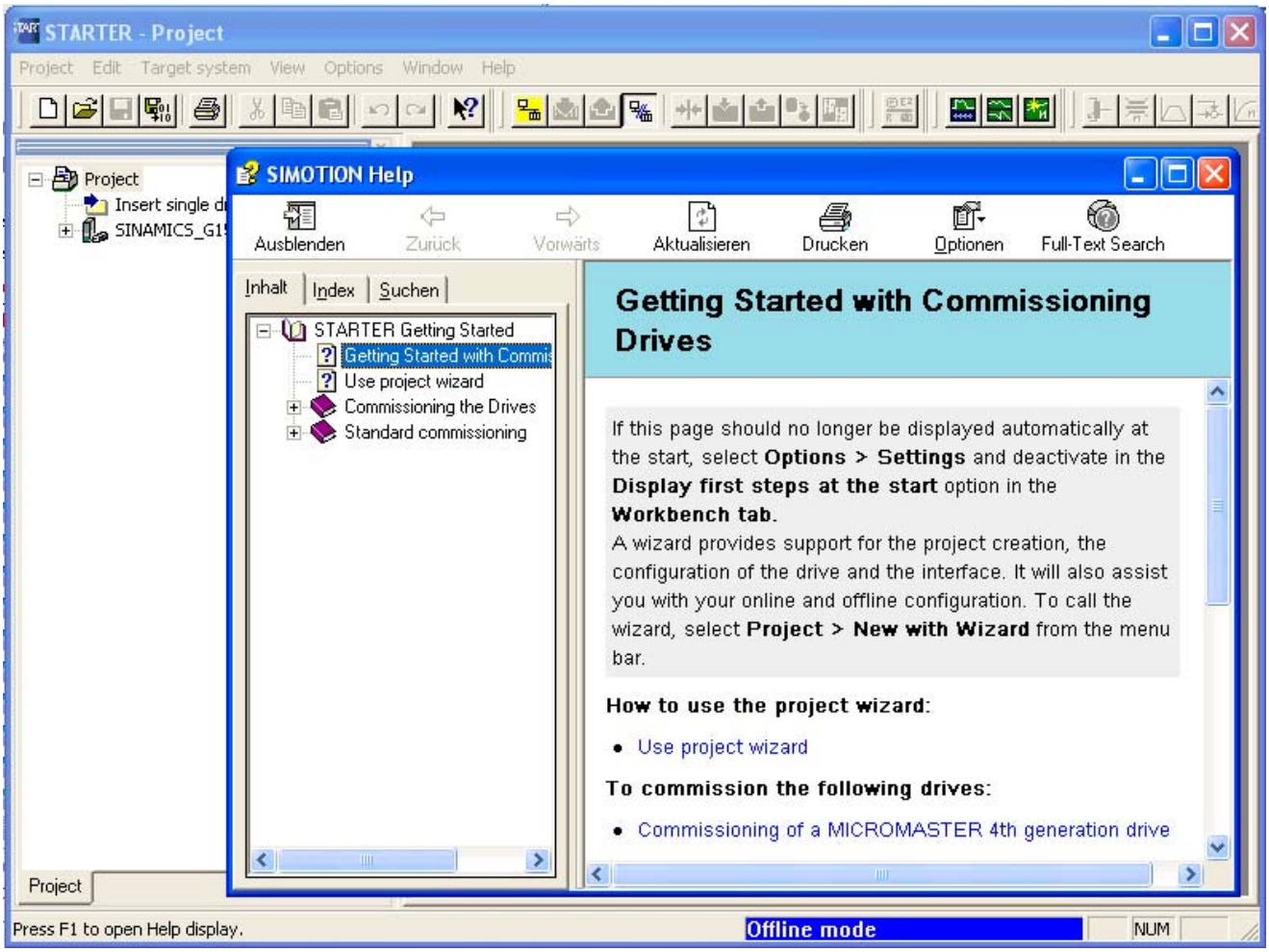

STARTER - Project
Project Edit Target system View Options Window Help
Project
Insert single d
SINAMICS_G1
SIMOTION Help
Ausblenden
Zurück
Vorwärts
Aktualisieren
Drucken
Optionen
Full-Text Search
Inhalt
Index
Suchen
STARTER Getting Started
Getting Started with Commi
Use project wizard
Commissioning the Drives
Standard commissioning
Getting Started with Commissioning Drives
If this page should no longer be displayed automatically at the start, select Options > Settings and deactivate in the Display first steps at the start option in the Workbench tab.
A wizard provides support for the project creation, the configuration of the drive and the interface. It will also assist you with your online and offline configuration. To call the wizard, select Project > New with Wizard from the menu bar.
How to use the project wizard:
Use project wizard
To commission the following drives:
Commissioning of a MICROMASTER 4th generation drive
Project
Press F1 to open Help display.
Offline mode
NUM

Figure 5-2 Main screen of the STARTER parameterization and commissioning tool

1. Close the "STARTER Getting Started Drive Commissioning" screen by choosing **HTML Help > Close**.

Note

When you deactivate the **Display Wizard during start** checkbox, the project Wizard is no longer displayed the next time you start STARTER.

You can call up the project Wizard by choosing **Projec > New with Wizard**.

To deactivate the online help for **Getting Started**, follow the instructions provided in Help.

You can call up the online help at any time by choosing **Help > Getting Started**.

STARTER features a detailed online help function.

The STARTER project Wizard

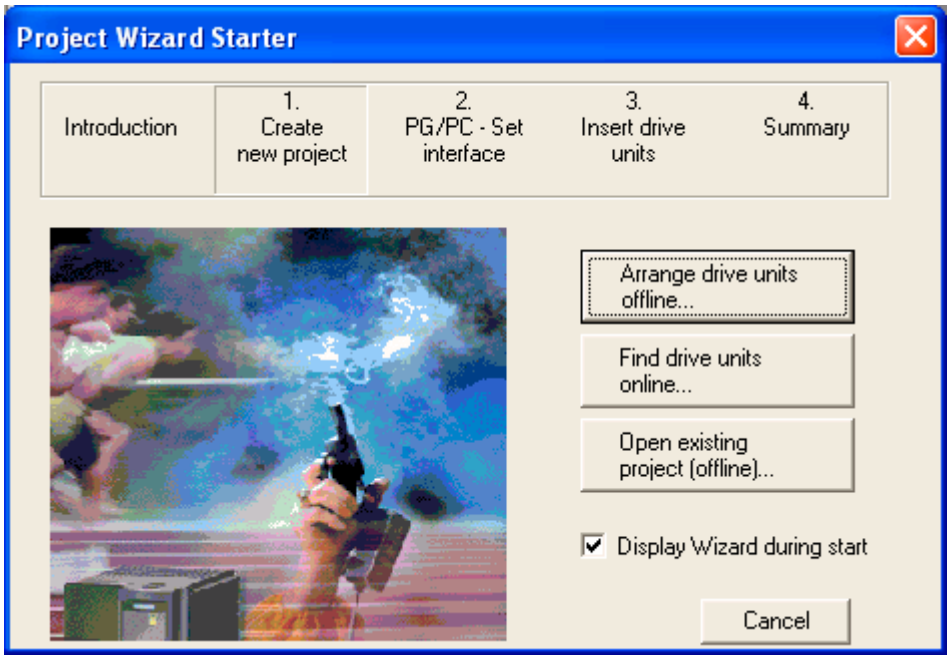


Figure 5-3 STARTER project Wizard

2. Click **Arrange drive units offline...** in the STARTER project Wizard.

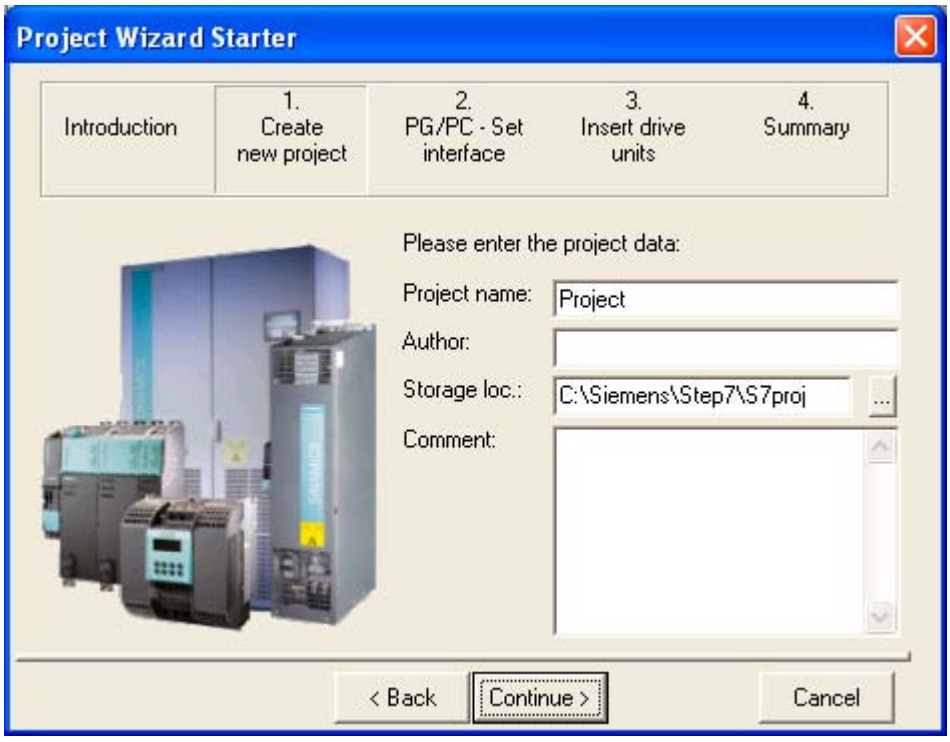


Figure 5-4 Create new project

3. Enter a **project name** and, if necessary, the **author, memory location** and a **comment**.
4. Click **Continue >** to set up the PG/PC interface.

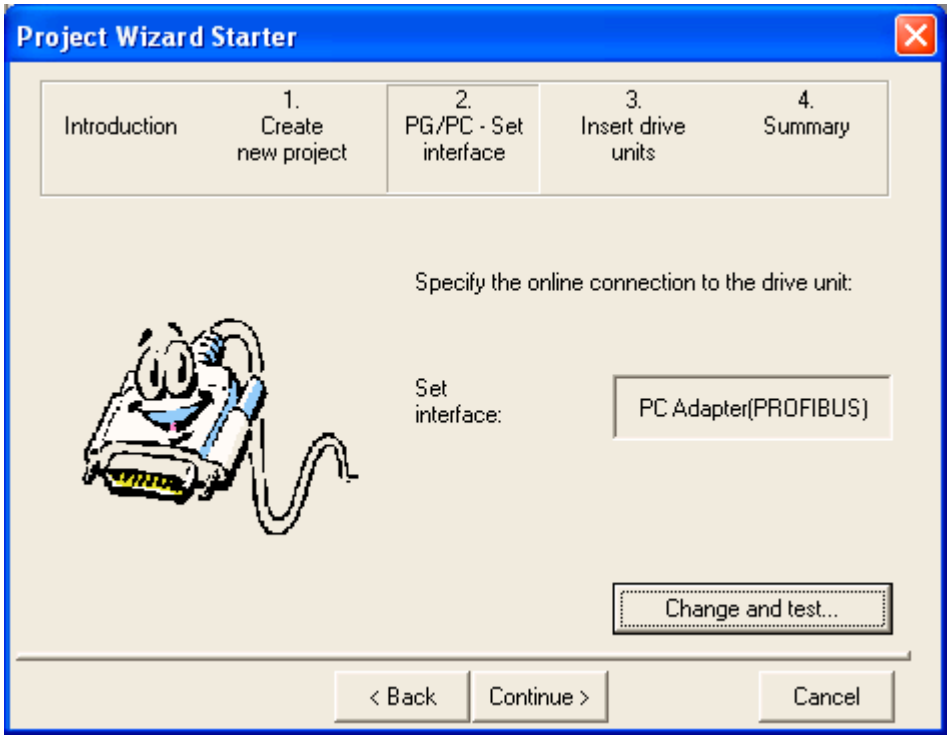


Figure 5-5 Set up interface

Note

The online connection to the drive unit can only be established via PROFIBUS.

5. Click **Change and test...** and set up the interface in accordance with your device configuration.
The **Properties...**, **Copy...**, and **Select...** pushbuttons are now active.

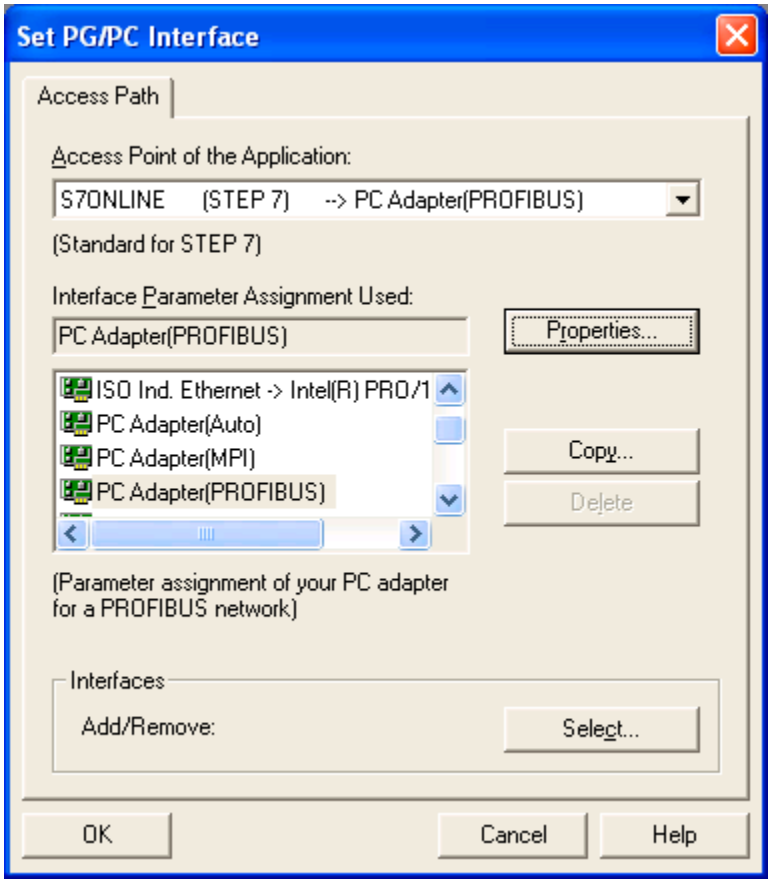


Figure 5-6 Setting the interface

Note

To parameterize the interface, you must install an appropriate interface card, e.g., PC adapter (PROFIBUS).

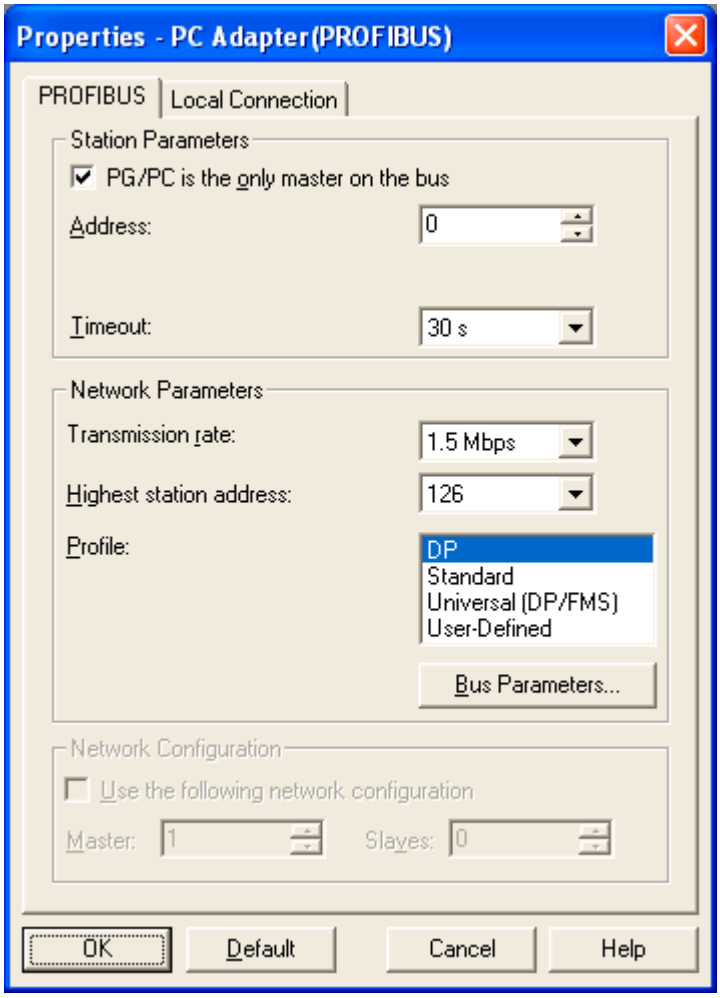


Figure 5-7 Setting the interface - properties

NOTICE
You must activate **PG/PC is the only master on bus** if no other master (PC, S7, etc.) is available on the bus.

Note

Projects can be created and PROFIBUS addresses for the drive objects assigned even if a PROFIBUS interface has not been installed on the PC.

To prevent bus addresses from being assigned more than once, only the bus addresses available in the project are proposed.

6. Once you have done this, click **OK** to confirm the settings and return to the project Wizard.

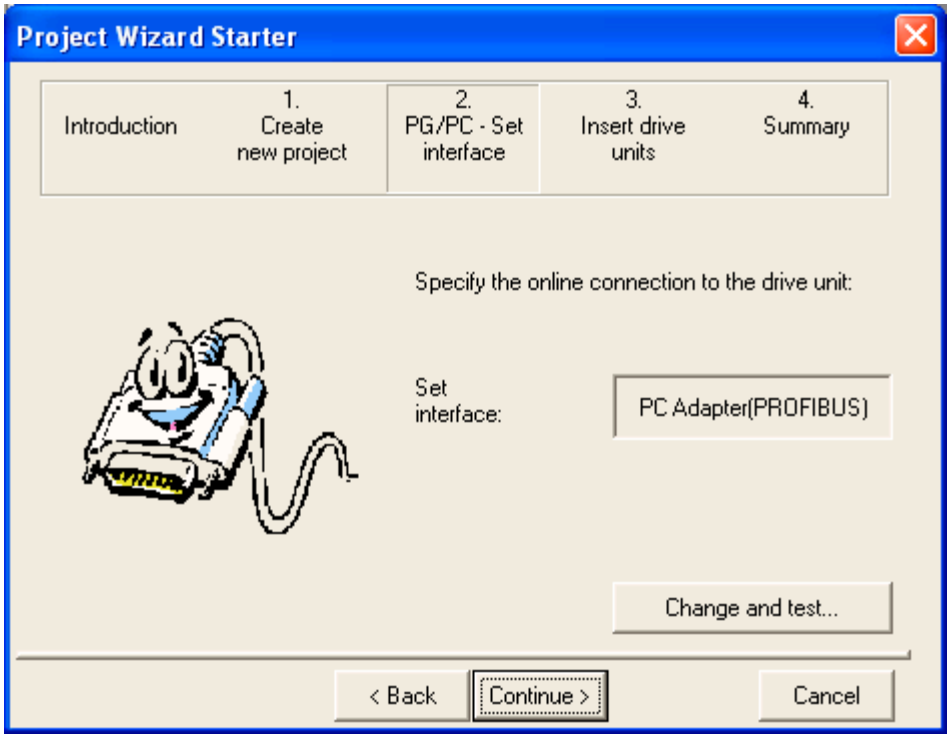


Figure 5-8 Setting the interface

7. Click **Continue >** to set up a drive unit in the project Wizard.

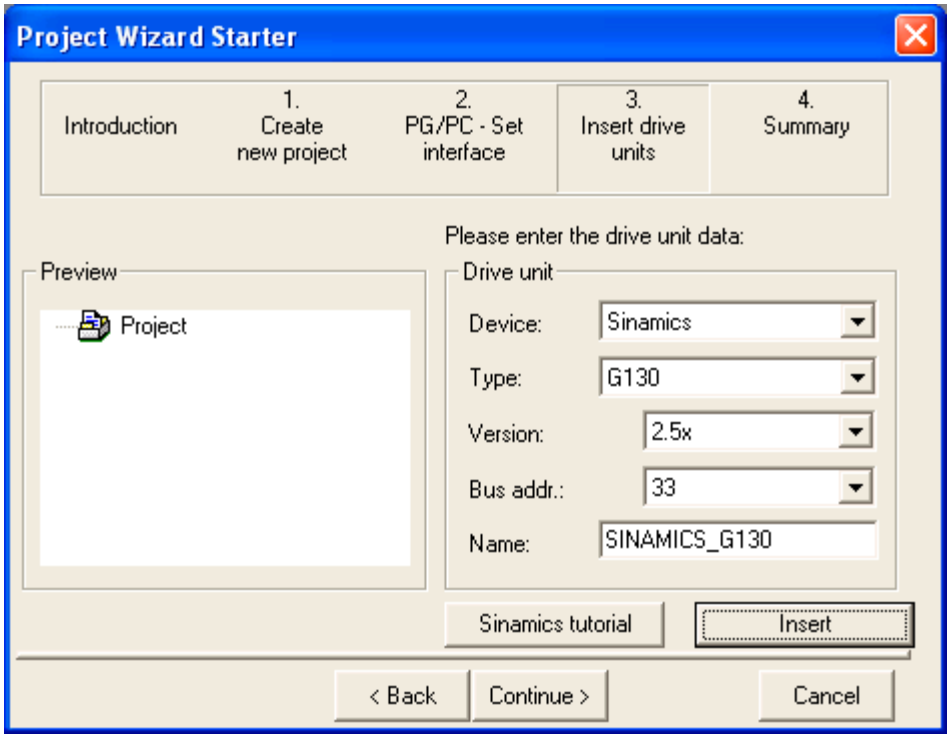


Figure 5-9 Inserting the drive unit

8. Choose the following data from the list fields:
Device: Sinamics
Type: G130
Version: v2.5
Bus address: the corresponding bus address for the converter.
The entry in the **Name:** field is user defined.

9: Click **Insert**
The selected drive unit is displayed in a preview window in the project wizard.

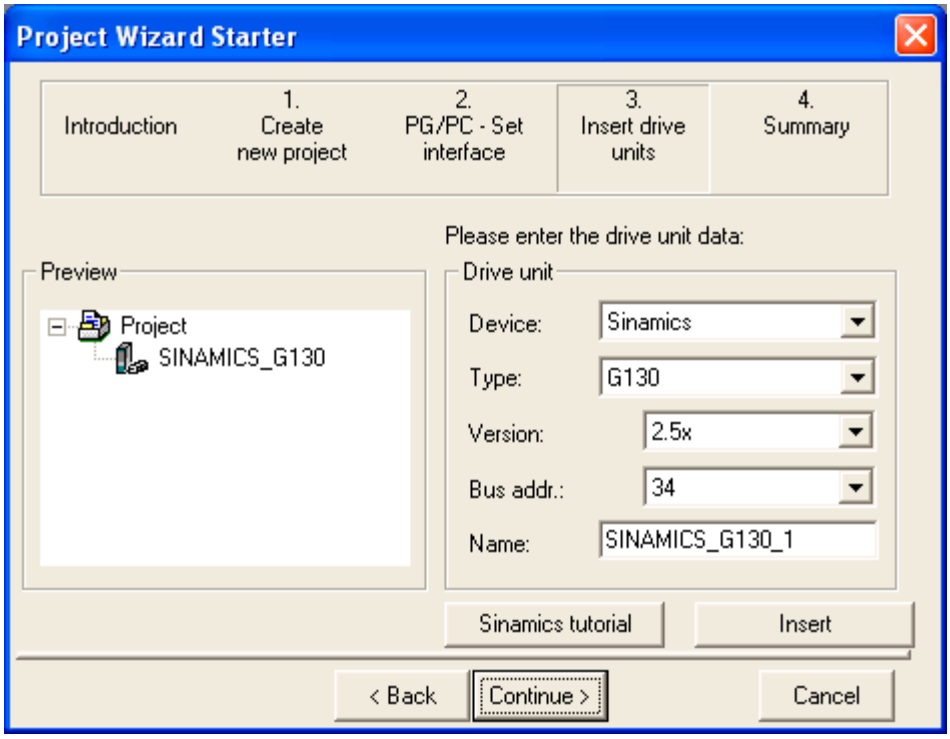


Figure 5-10 Inserting the drive unit

10. Click **Continue >**
A project summary is displayed.

Figure 5-11 Summary

11. Click **Complete** to finish creating a new drive unit project.

5.3.2 Configuring the drive unit

In the project navigator, open the component that contains your drive unit.

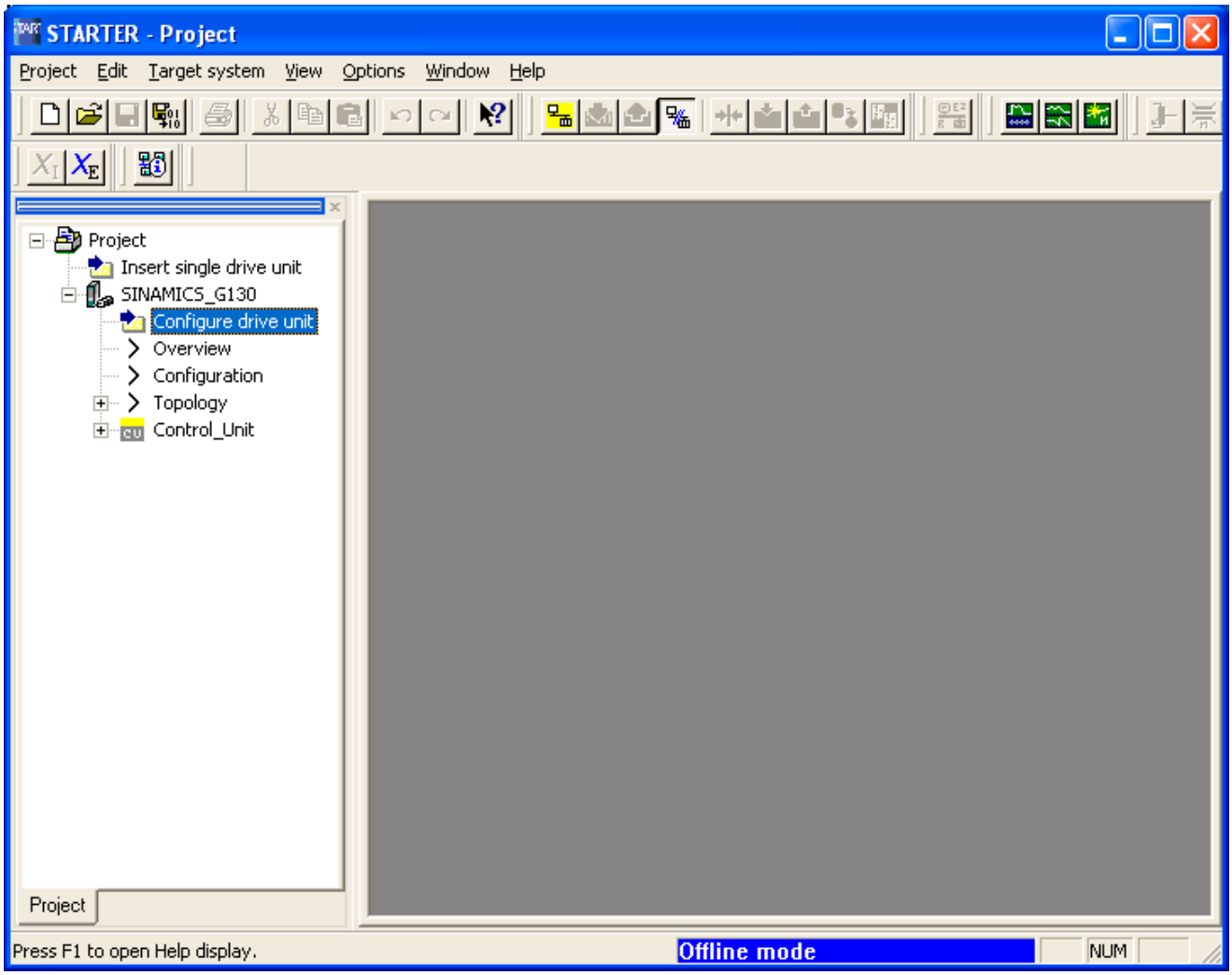


Figure 5-12 Project navigator – configuring the drive unit

1. In the project navigator, click the plus sign next to the drive unit that you want to configure. The plus sign becomes a minus sign and the drive unit configuration options are displayed as a tree below the drive unit.
2. Double-click **Configure drive unit**.

Configuring the drive unit

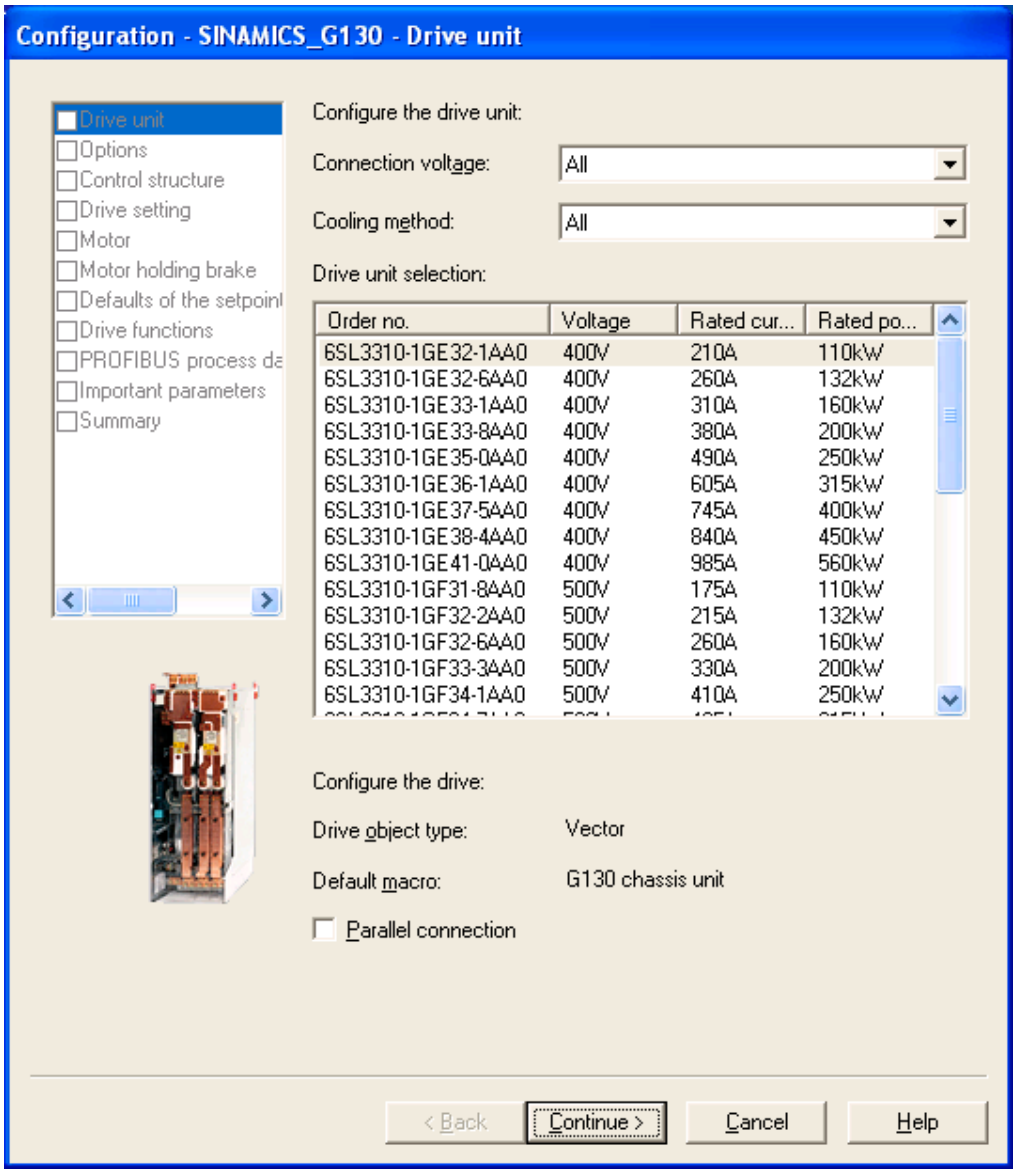


Figure 5-13 Configuring the drive unit

3. Under **Voltage selection**, choose the correct voltage. Under **Cooling type:** , choose the correct cooling type for your drive unit.

Note

In this step, you make a preliminary selection of the chassis units. You do not define the supply voltage and cooling type yet.

4. A list is now displayed under **Drive unit selection**. Choose the corresponding drive unit according to type (order no.) (see type plate).

5. Click **Continue >**.

Choosing the options

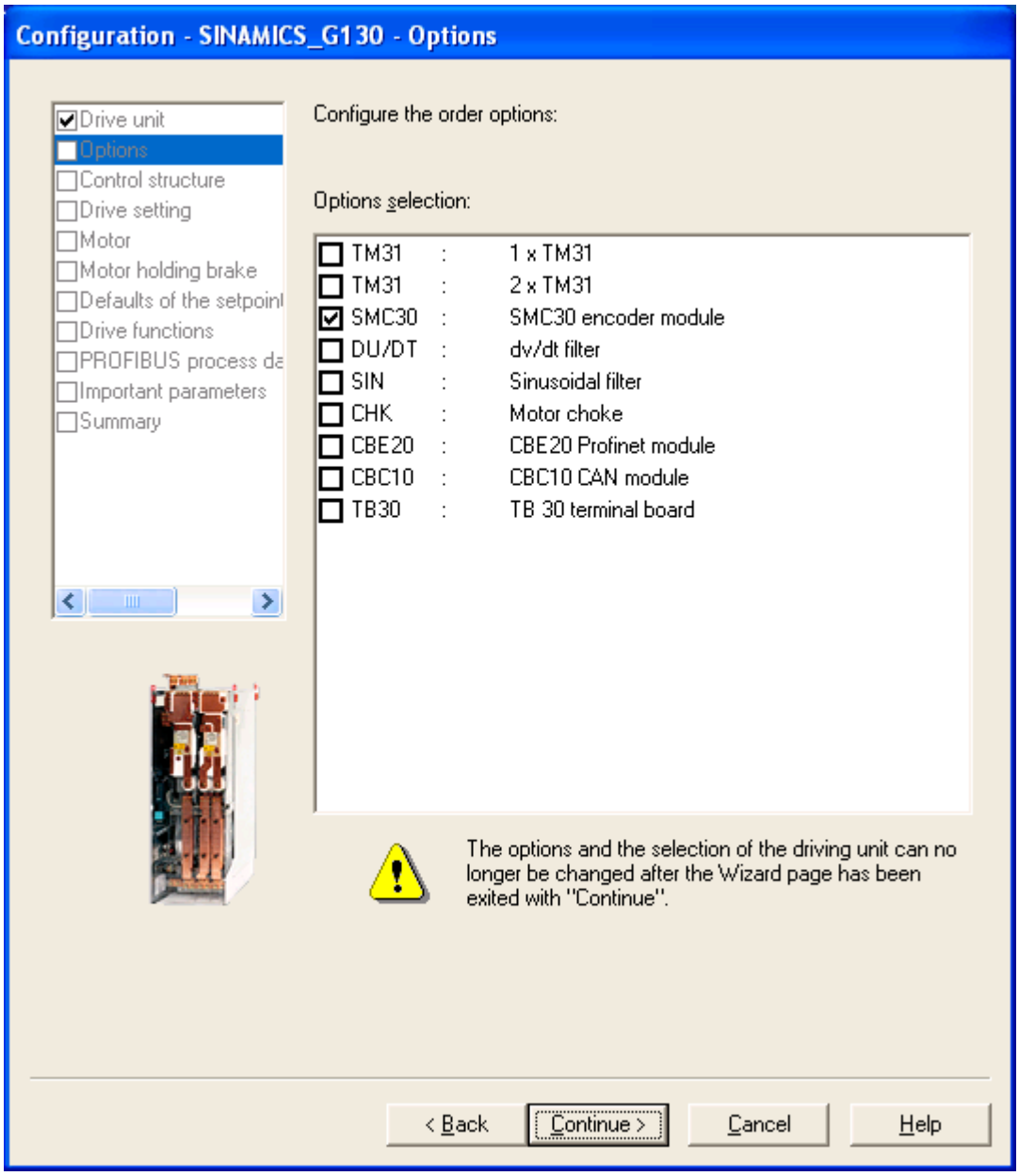


Figure 5-14 Choosing the options

6. From the combination box **Choosing the options:** select the options belonging to your drive unit by clicking on the corresponding check box.

CAUTION
If a sine-wave filter is connected, it must be activated when the options are selected to prevent the filter from being destroyed.

Note

Carefully check whether the selected options are connected to your built-in unit.

Since the wizard establishes internal interconnections on the basis of the options selected, you cannot change the selected options by clicking **< Back**.
If you make an incorrect entry, delete the entire drive unit from the project navigator and create a new one.

7. Check your options carefully and then click **Continue >**

Selecting the control structure

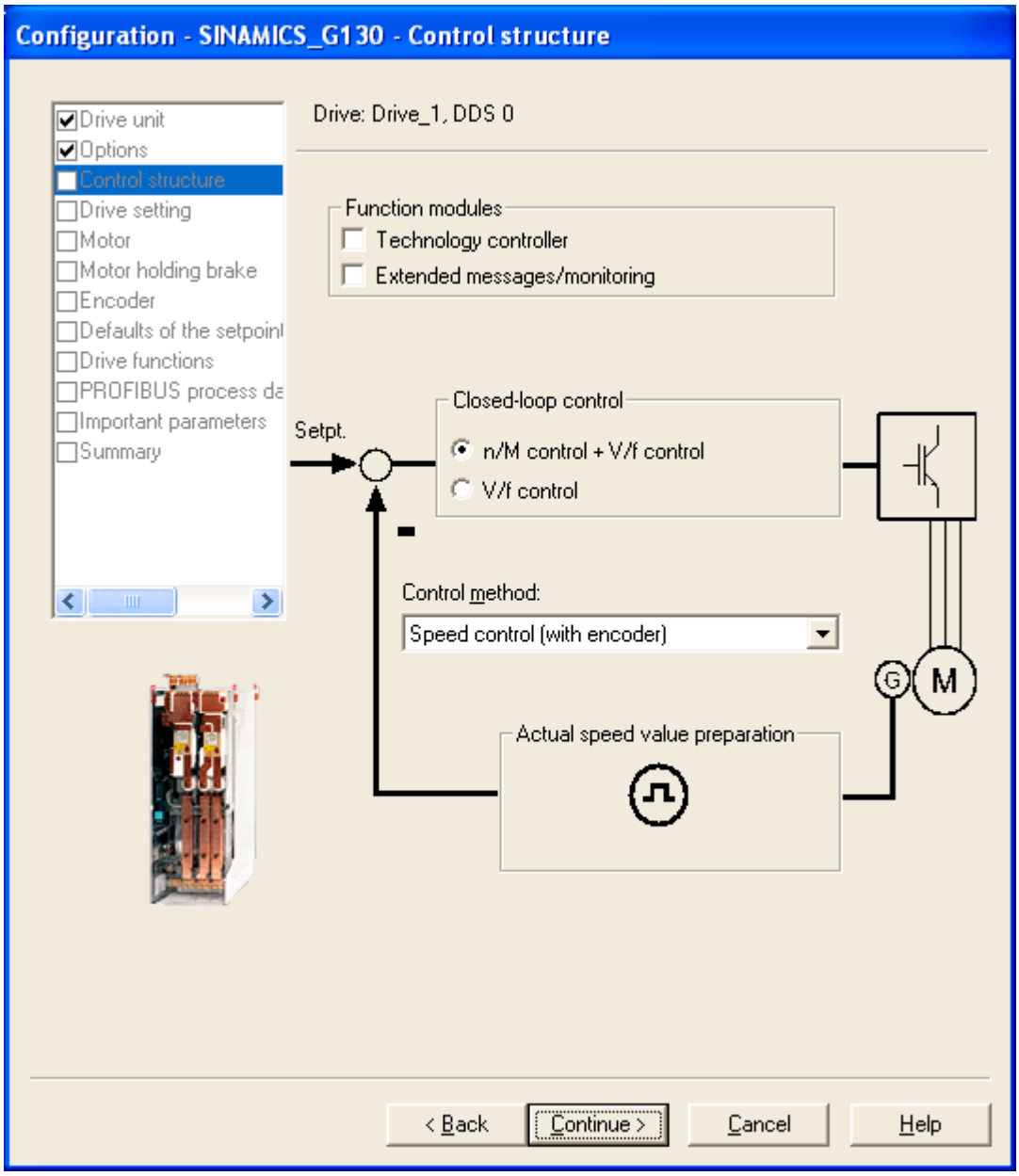


Figure 5-15 Selecting the control structure

8. Select the required data:

- **Function modules:**
  - Technology controller
  - Extended messages/monitoring

- **Control method:**
  choose one of the following open-loop/closed-loop control types:
  - Torque control (sensorless)
  - Torque control (with encoder)
  - Speed control (sensorless)
  - Speed control (with encoder)
  - I/f control with fixed current
  - V/f control for drive requiring a precise frequency (e.g. textiles)
  - V/f control for drive requiring a precise frequency with FCC
  - V/f control with linear characteristic
  - V/f control with linear characteristic and FCC
  - V/f control with parabolic characteristic
  - V/f control with parameterizable characteristic
  - V/f control with independent voltage setpoint

9. Click **Continue >**.

Configuring the drive unit properties

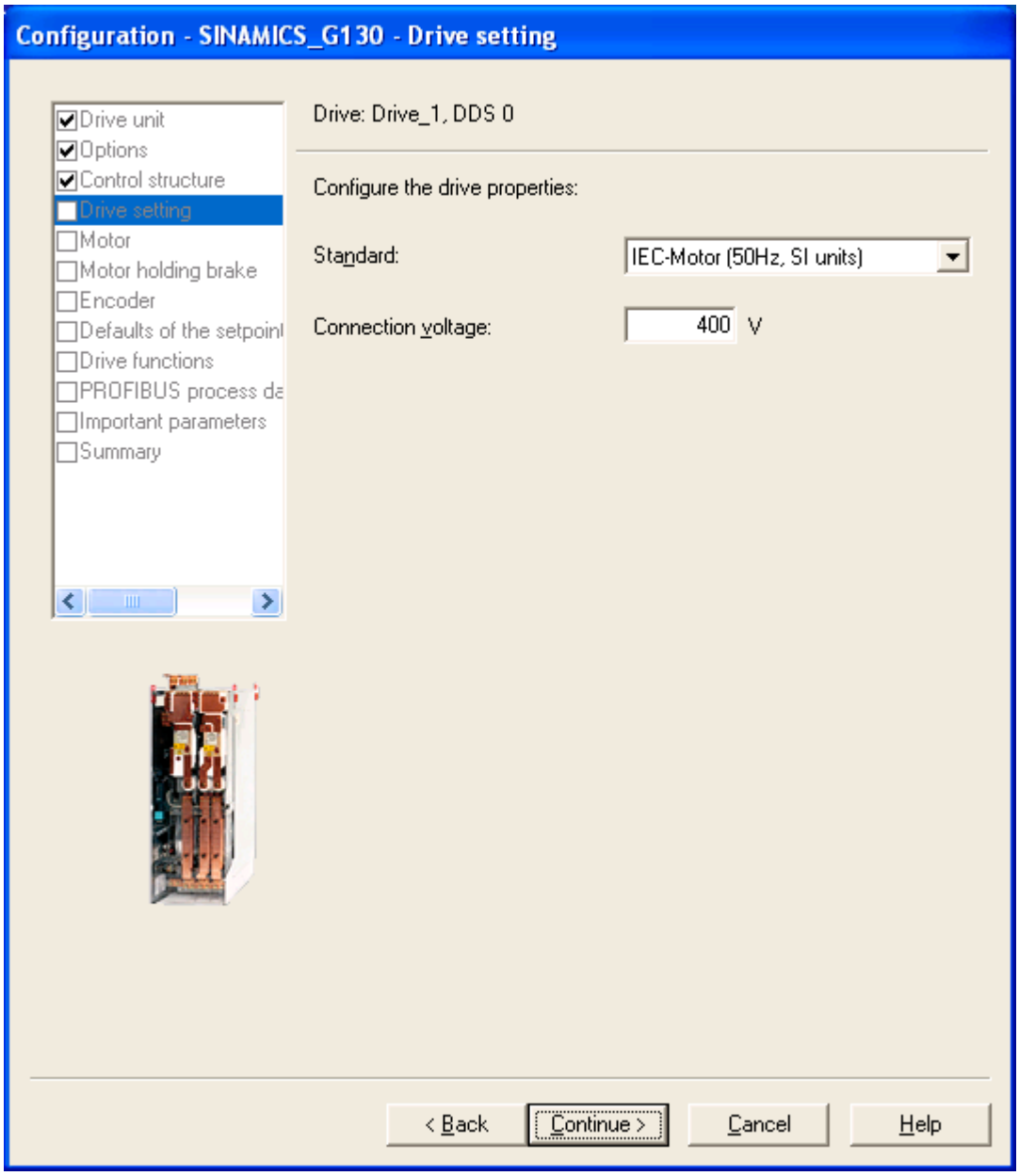


Figure 5-16 Configuring the drive unit properties

10. Under **Standard**, choose the appropriate standard for your motor, whereby the following is defined:
    - IEC motor (50 Hz, SI unit): line frequency 50 Hz, motor data in kW
    - NEMA motor (60 Hz, US unit): line frequency 60 Hz, motor data in hp
11. Under **Supply voltage:**, enter the appropriate voltage of the device.
12. Click **Continue >**.

Configuring the motor and selecting the motor type

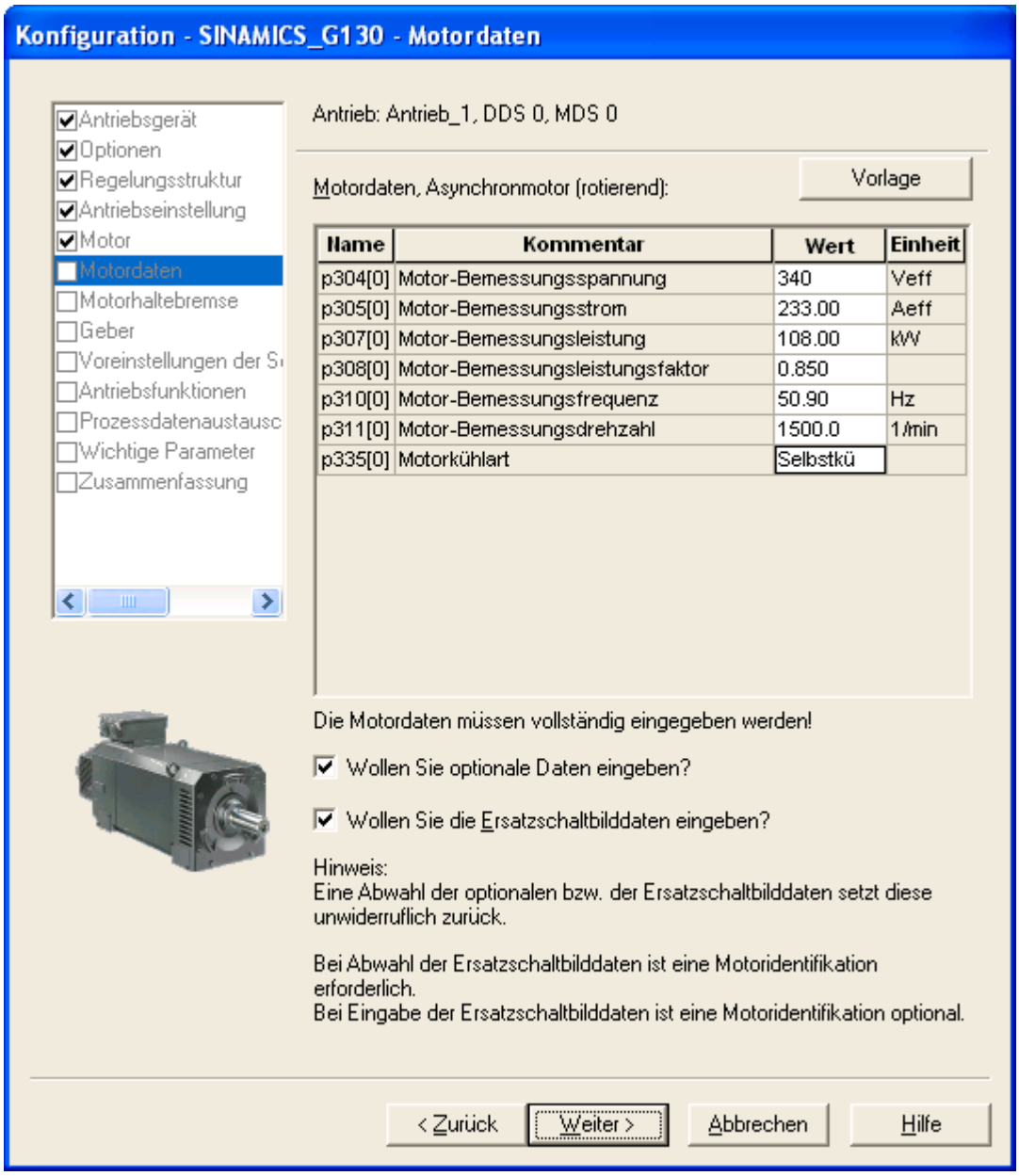


Figure 5-17 Configuring the motor and selecting the motor type

13. Under **Name** , choose a name for the motor.

14. From the selection box next to **Motor type:** select the appropriate motor for your application.

Note

The steps described below also apply to induction motors.

When commissioning a permanent-magnet synchronous motor, there are a few special conditions, which are detailed in a separate chapter (see "Setpoint channel and closed-loop control/Permanent-magnet synchronous motors").

15. Click **Continue >**.

Configuring the motor and entering motor data

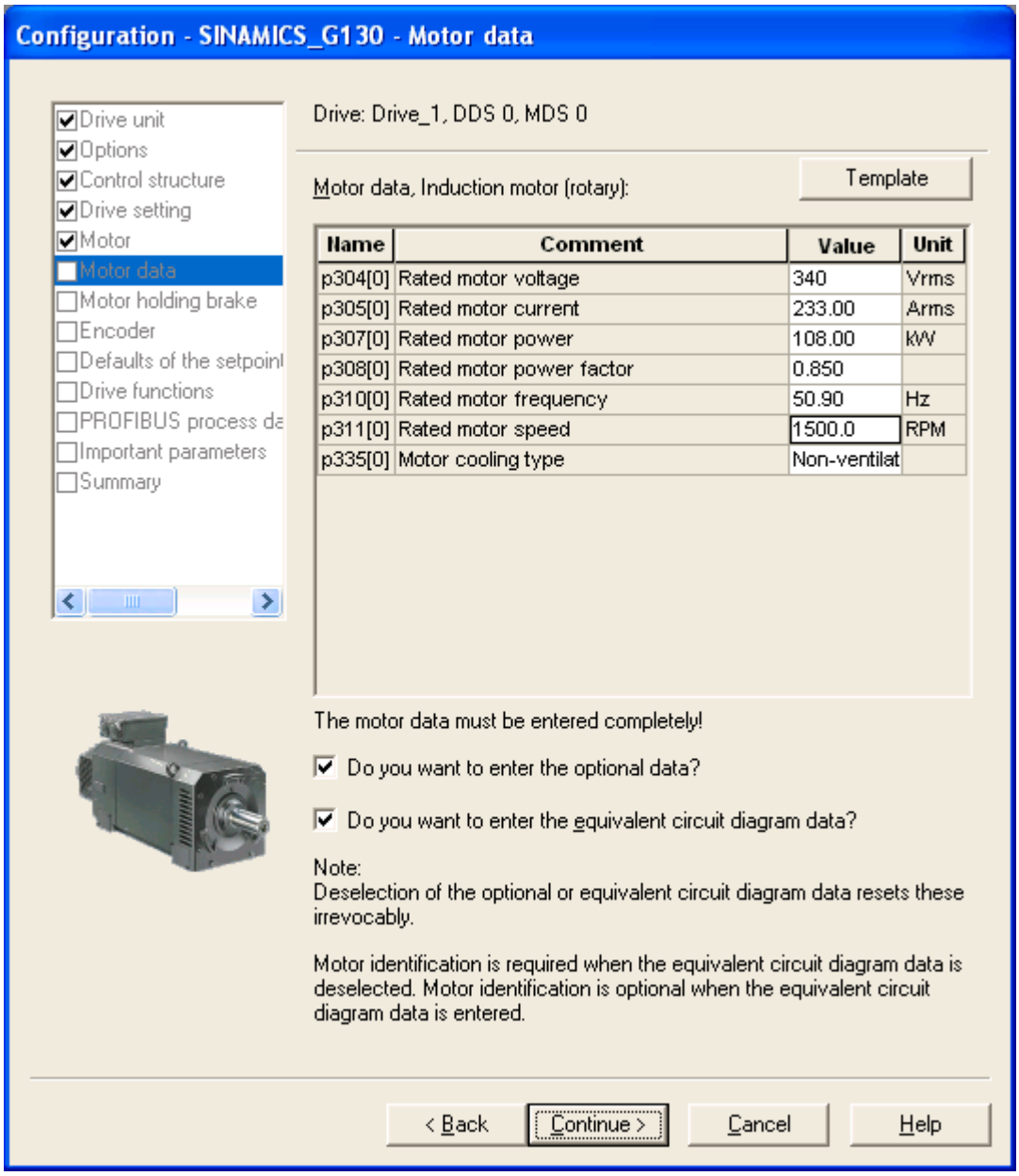

Configuration - SINAMICS_G130 - Motor data
Drive unit
Options
Control structure
Drive setting
Motor
Motor data
Motor holding brake
Encoder
Defaults of the setpoint
Drive functions
PROFIBUS process da
Important parameters
Summary
Drive: Drive_1, DDS 0, MDS 0
Motor data, Induction motor (rotary):
Template
Name
Comment
Value
Unit
p304[0] Rated motor voltage 340 Vrms
p305[0] Rated motor current 233.00 Arms
p307[0] Rated motor power 108.00 kW
p308[0] Rated motor power factor 0.850
p310[0] Rated motor frequency 50.90 Hz
p311[0] Rated motor speed 1500.0 RPM
p335[0] Motor cooling type Non-ventilat
The motor data must be entered completely!
Do you want to enter the optional data?
Do you want to enter the equivalent circuit diagram data?
Note:
Deselection of the optional or equivalent circuit diagram data resets these irrevocably.
Motor identification is required when the equivalent circuit diagram data is deselected. Motor identification is optional when the equivalent circuit diagram data is entered.
< Back
Continue >
Cancel
Help

Figure 5-18 Configuring the motor and entering motor data

16. Enter the motor data (see motor type plate).
17. If necessary, activate **Do you want to enter the mechanical data?**
18. If necessary, activate **Do you want to enter the equivalent circuit diagram data?**

Note
Click **Template** to open another selection screenform where you can choose the motor used in your application from a long list of standard motor types. Select a motor from the list to enter the data stored in the system for that motor automatically in the data fields.

NOTICE
You should only check the "Do you want to enter equivalent circuit diagram data?" box if the data sheet with equivalent circuit diagram data is available. If any data is missing, an error message will be output when the system attempts to load the drive project to the target system.

19. Click **Continue >**.

Configuring the motor and entering optional data

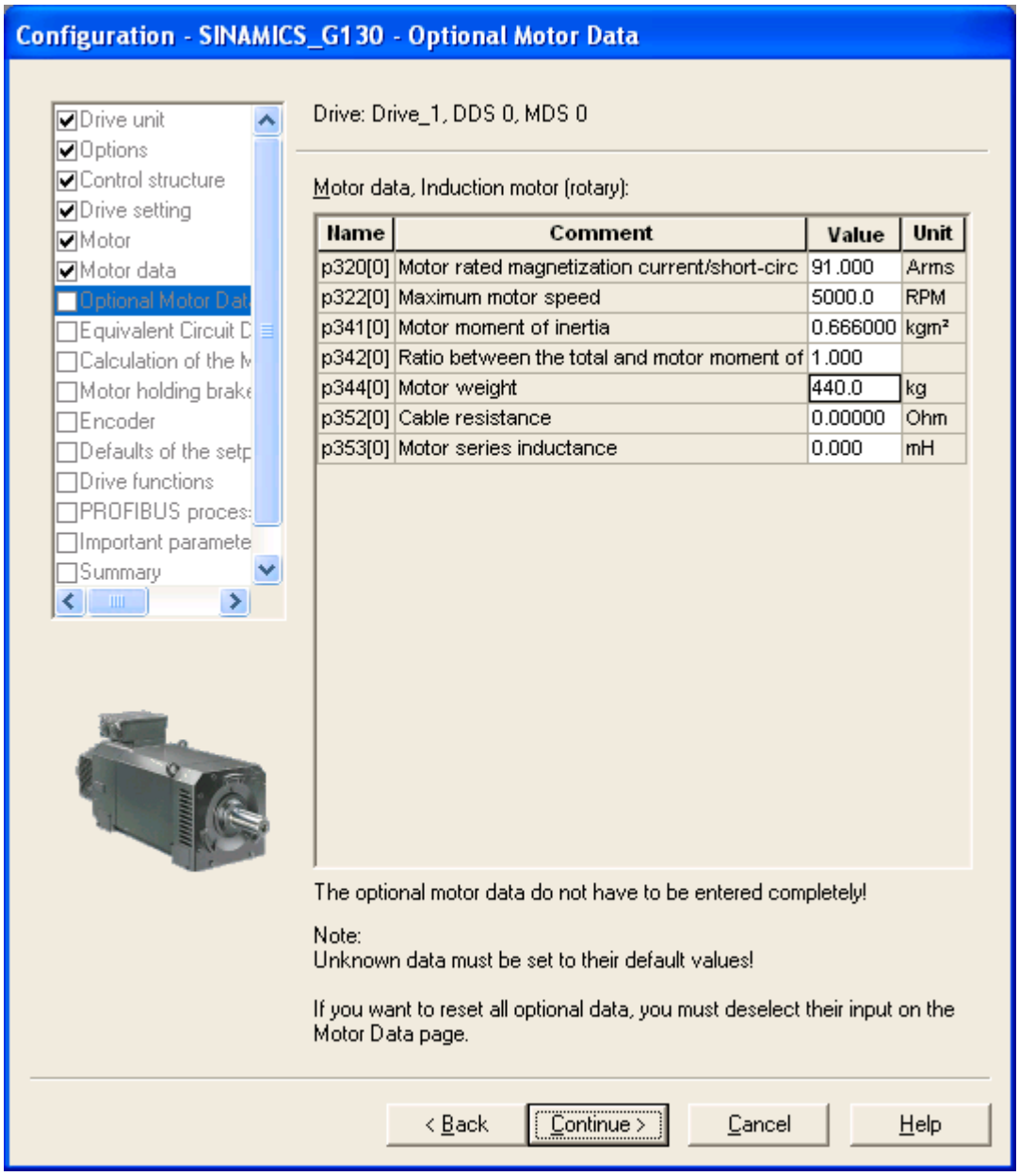

Configuration - SINAMICS_G130 - Optional Motor Data
Drive unit
Options
Control structure
Drive setting
Motor
Motor data
Optional Motor Dat
Equivalent Circuit D
Calculation of the M
Motor holding brake
Encoder
Defaults of the setp
Drive functions
PROFIBUS proces
Important paramete
Summary
Drive: Drive_1, DDS 0, MDS 0
Motor data, Induction motor (rotary):
Name
Comment
Value
Unit
p320[0] Motor rated magnetization current/short-circ 91.000 Arms
p322[0] Maximum motor speed 5000.0 RPM
p341[0] Motor moment of inertia 0.666000 kgm²
p342[0] Ratio between the total and motor moment of 1.000
p344[0] Motor weight 440.0 kg
p352[0] Cable resistance 0.00000 Ohm
p353[0] Motor series inductance 0.000 mH
The optional motor data do not have to be entered completely!
Note:
Unknown data must be set to their default values!
If you want to reset all optional data, you must deselect their input on the Motor Data page.
< Back
Continue >
Cancel
Help

Figure 5-19 Entering optional motor data

20. If necessary, enter the optional motor data.
21. Click **Continue >**.

Configuring the motor and entering the equivalent circuit diagram data

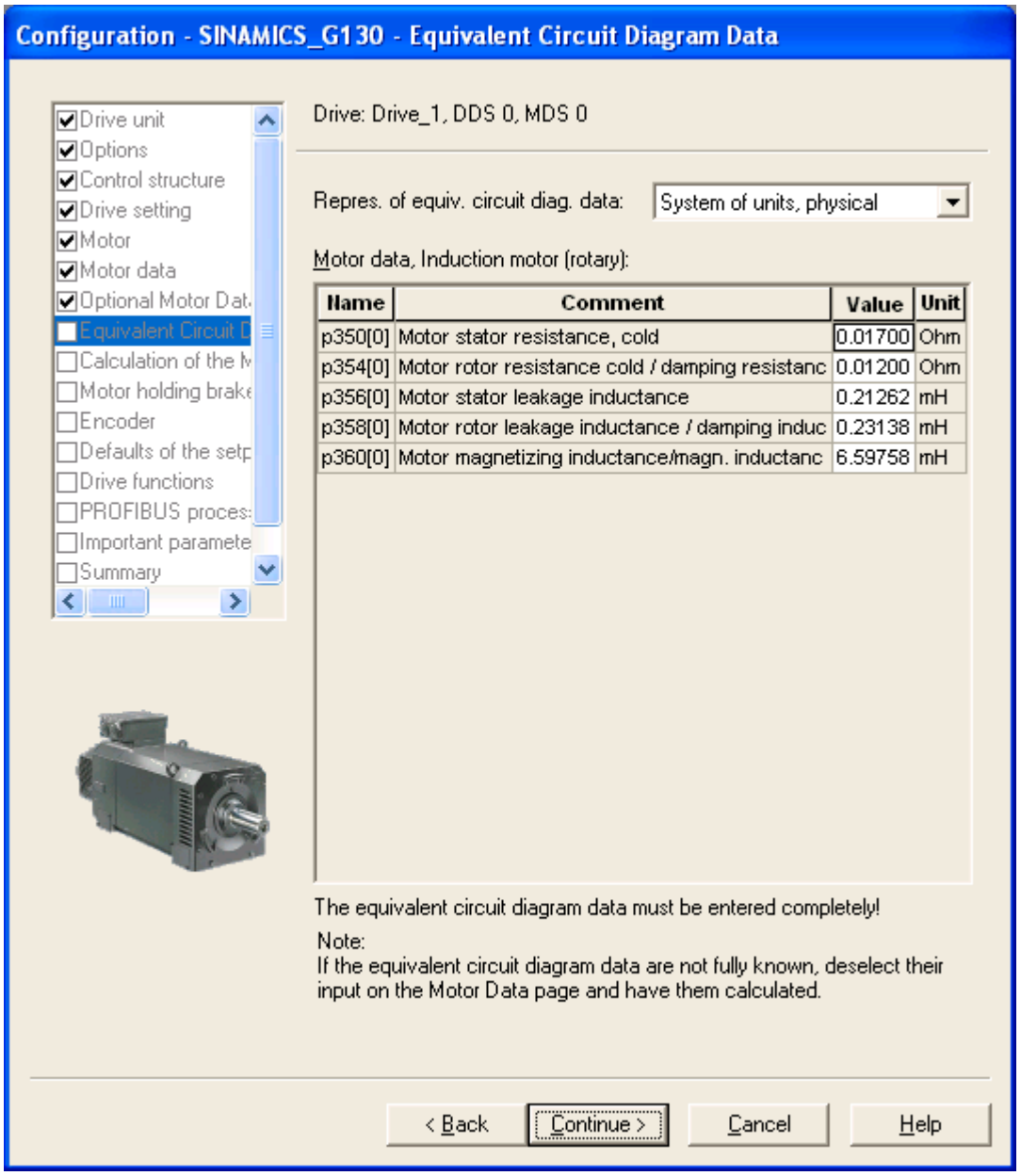

Configuration - SINAMICS_G130 - Equivalent Circuit Diagram Data
Drive unit
Options
Control structure
Drive setting
Motor
Motor data
Optional Motor Dat
Equivalent Circuit D
Calculation of the M
Motor holding brake
Encoder
Defaults of the setp
Drive functions
PROFIBUS proces
Important paramete
Summary
Drive: Drive_1, DDS 0, MDS 0
Repres. of equiv. circuit diag. data:
System of units, physical
Motor data, Induction motor (rotary):
Name
Comment
Value
Unit
p350[0] Motor stator resistance, cold 0.01700 Ohm
p354[0] Motor rotor resistance cold / damping resistanc 0.01200 Ohm
p356[0] Motor stator leakage inductance 0.21262 mH
p358[0] Motor rotor leakage inductance / damping induc 0.23138 mH
p360[0] Motor magnetizing inductance/magn. inductanc 6.59758 mH
The equivalent circuit diagram data must be entered completely!
Note:
If the equivalent circuit diagram data are not fully known, deselect their input on the Motor Data page and have them calculated.
< Back
Continue >
Cancel
Help

Figure 5-20 Entering equivalent circuit diagram data

22. If necessary, enter the equivalent circuit diagram data.
23. Click **Continue >**.

Calculating the motor/controller data

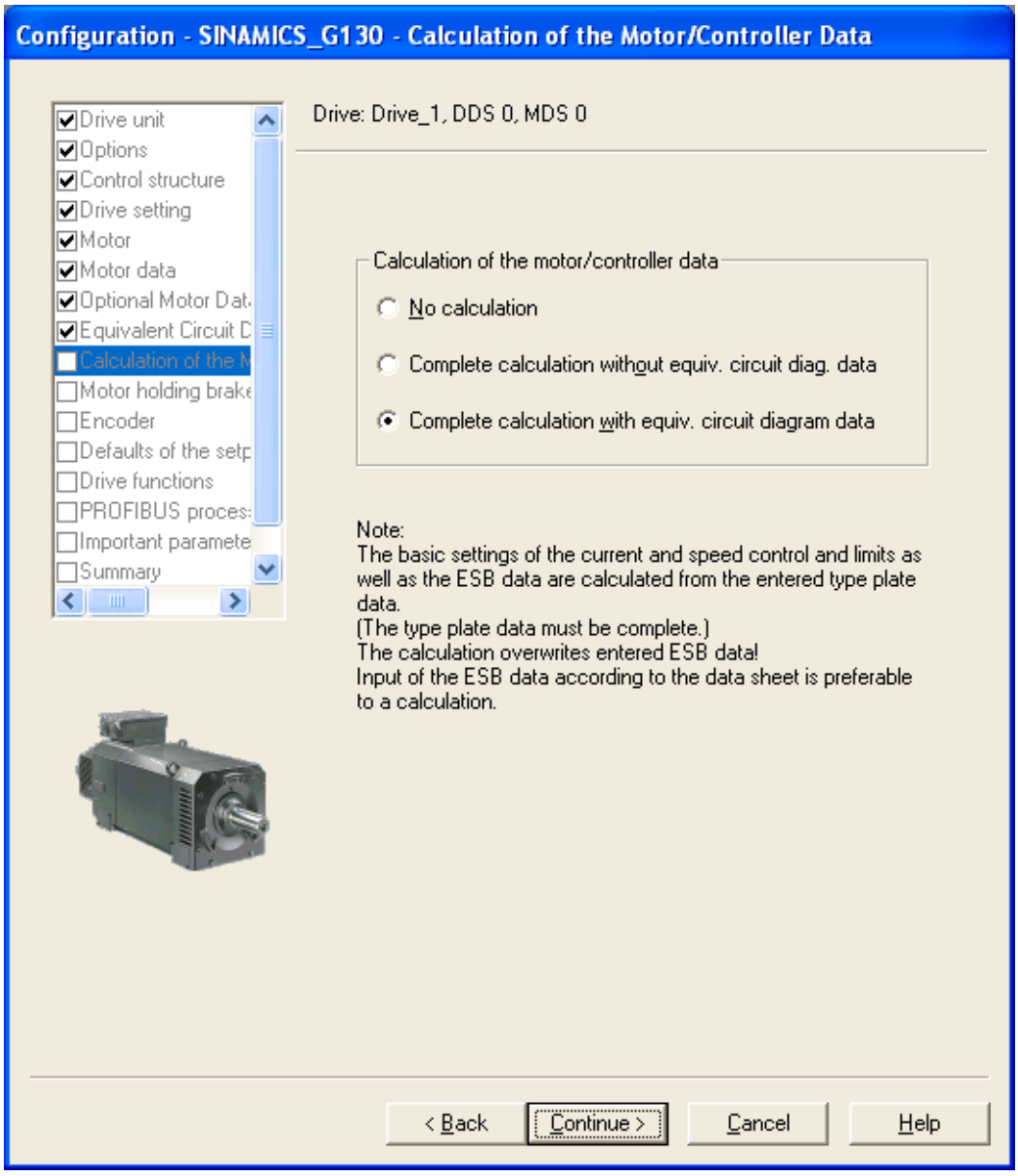

Configuration - SINAMICS_G130 - Calculation of the Motor/Controller Data
Drive unit
Options
Control structure
Drive setting
Motor
Motor data
Optional Motor Dat
Equivalent Circuit D
Calculation of the M
Motor holding brake
Encoder
Defaults of the setp
Drive functions
PROFIBUS proces
Important paramete
Summary
Drive: Drive_1, DDS 0, MDS 0
Calculation of the motor/controller data
No calculation
Complete calculation without equiv. circuit diag. data
Complete calculation with equiv. circuit diagram data
Note:
The basic settings of the current and speed control and limits as well as the ESB data are calculated from the entered type plate data.
(The type plate data must be complete.)
The calculation overwrites entered ESB data!
Input of the ESB data according to the data sheet is preferable to a calculation.
< Back
Continue >
Cancel
Help

Figure 5-21 Calculating the motor/controller data

24. In **Calculation of the motor/controller data**, choose the appropriate default settings for your device configuration.

Note

If the equivalent circuit diagram data was entered manually (see "Entering the equivalent circuit diagram data"), the motor/controller data should be calculated without calculating the equivalent circuit diagram data.

25. Click **Continue >**.

Configuring the motor holding brake

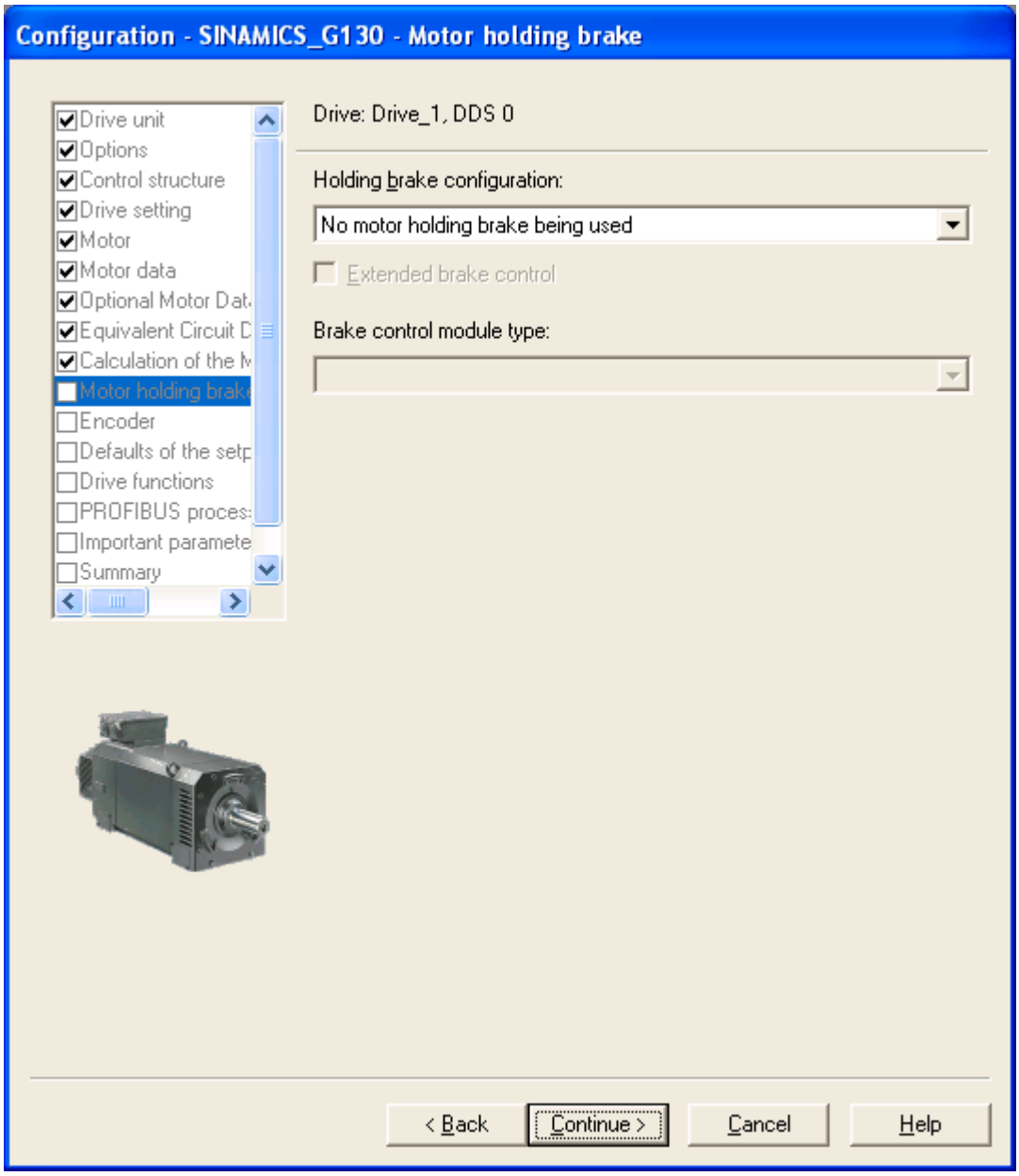


Figure 5-22 Configuring the motor holding brake

26. Under **Holding brake configuration:** choose the appropriate settings for your device configuration.

27. Click **Continue >**.

Entering the encoder data (option: SMC30 Sensor Module)

Note

If you specified the SMC30 Sensor Module when choosing the options, the following screen is displayed in which you can enter the encoder data.

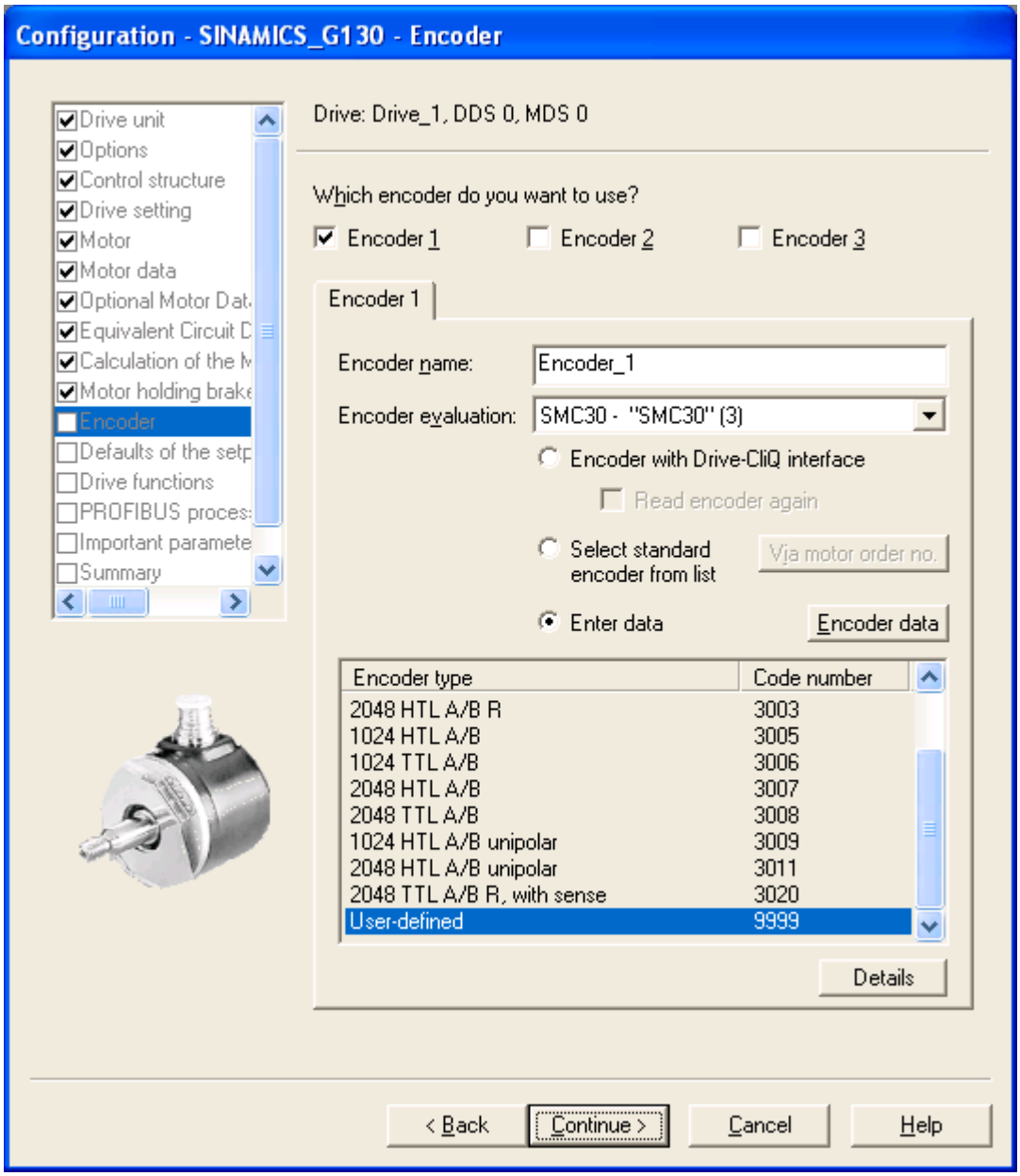


Figure 5-23 Entering the encoder data

28. In the **Name:** field, enter a name of your choice.

Note

In the factory setting, an HTL encoder is bipolar with 1024 pulses per revolution on terminal block X521/X531 of the SMC30 Sensor Module.

29. To select a different predefined encoder configuration, check the **Select standard encoder from list** radio button and select one of the encoders from the list.

30. To enter special encoder configurations, click the **Enter data** radio button and then the **Encoder data** button. The following screen is displayed in which you can enter the required data.

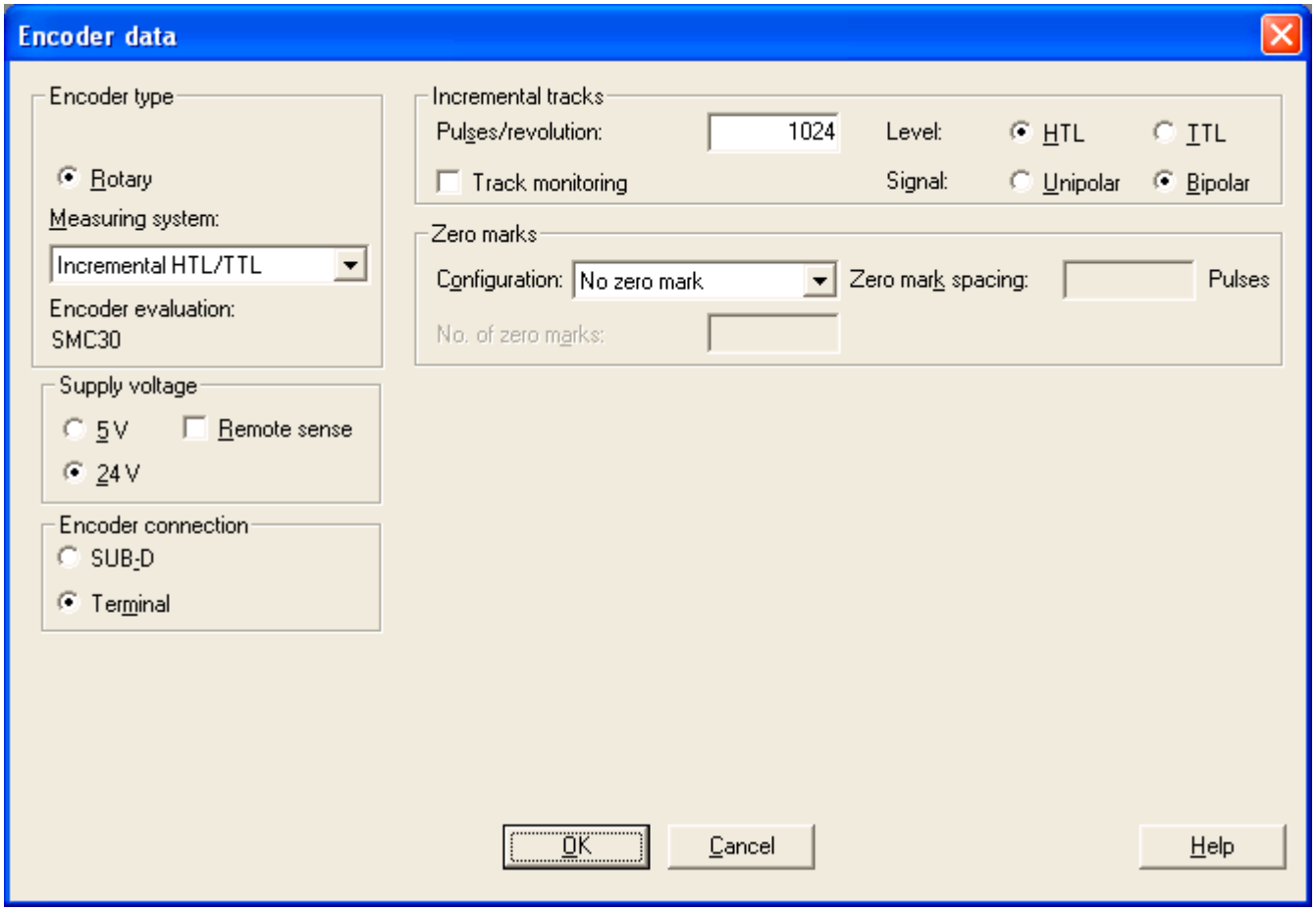


Figure 5-24 Entering encoder data – user-defined encoder data

31. Select the **measuring system**.
You can choose the following encoders:

- HTL
- TTL

32. Enter the required encoder data.

33. Then click **OK**.

CAUTION
Once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5 V encoder is connected and the supply voltage has not been set correctly, the encoder may be damaged.

Default settings for setpoints/command sources

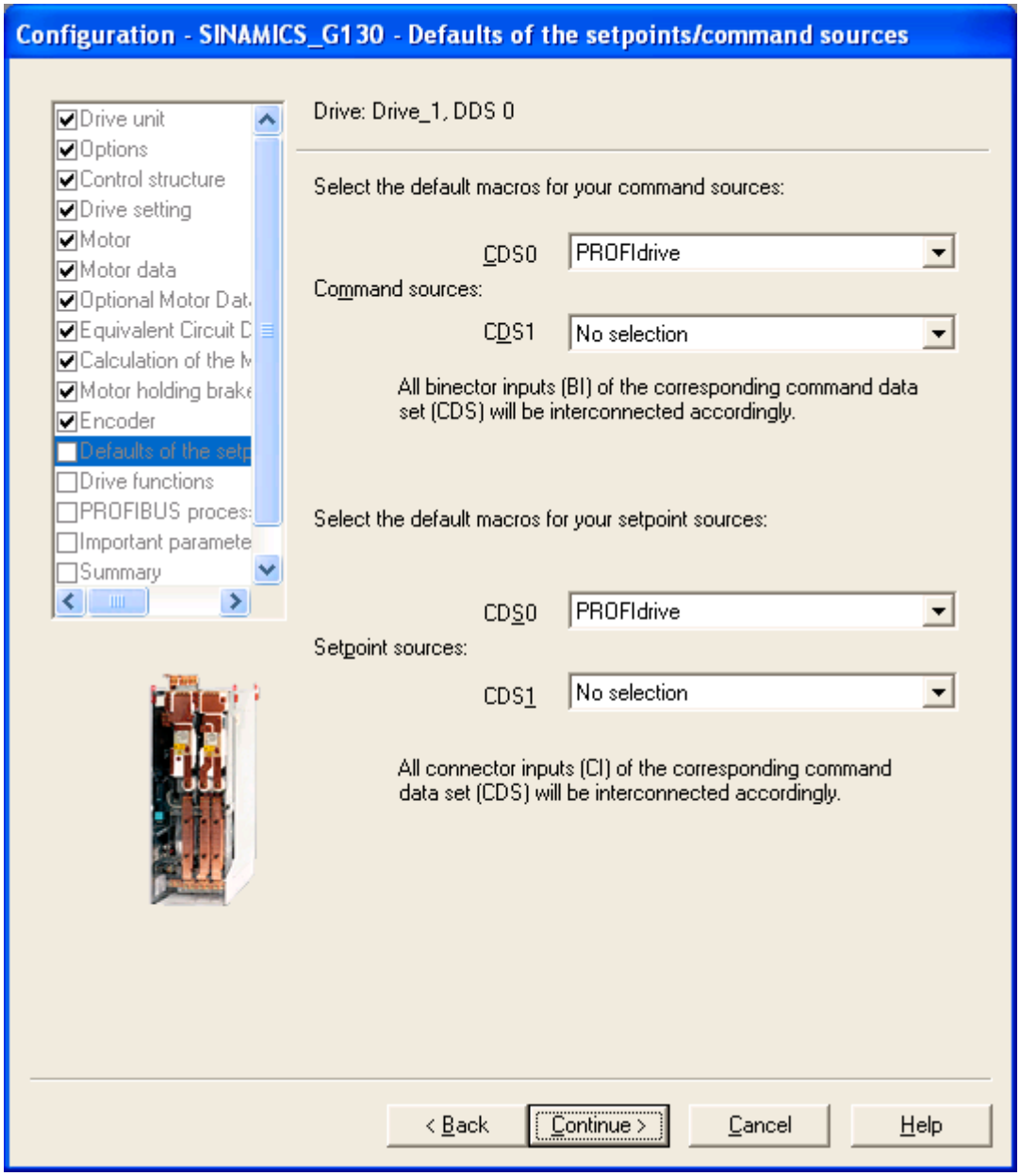


Figure 5-25 Default settings for setpoints/command sources

34. Under **Command sources:** and **Setpoint sources:** choose the appropriate settings for your device configuration.

The following command and setpoint source options are available:

Command sources:	PROFIdrive
	TM31 terminals
	CU terminals
	PROFIdrive+TM31
Setpoint sources:	PROFIdrive
	TM31 terminals
	Motorized potentiometer
	Fixed setpoint

Note

With SINAMICS G130, only CDS0 is normally used as a default setting for the command and setpoint sources.

Make sure that the selected default setting is compatible with the actual system configuration.

You cannot change the selected default setting by clicking **< Back** (unless the current setting is "No selection").
If you make an incorrect entry, delete the entire drive unit from the project navigator and create a new one.

35. Check your default selections carefully and then click **Continue >**

Defining the technological application/motor identification

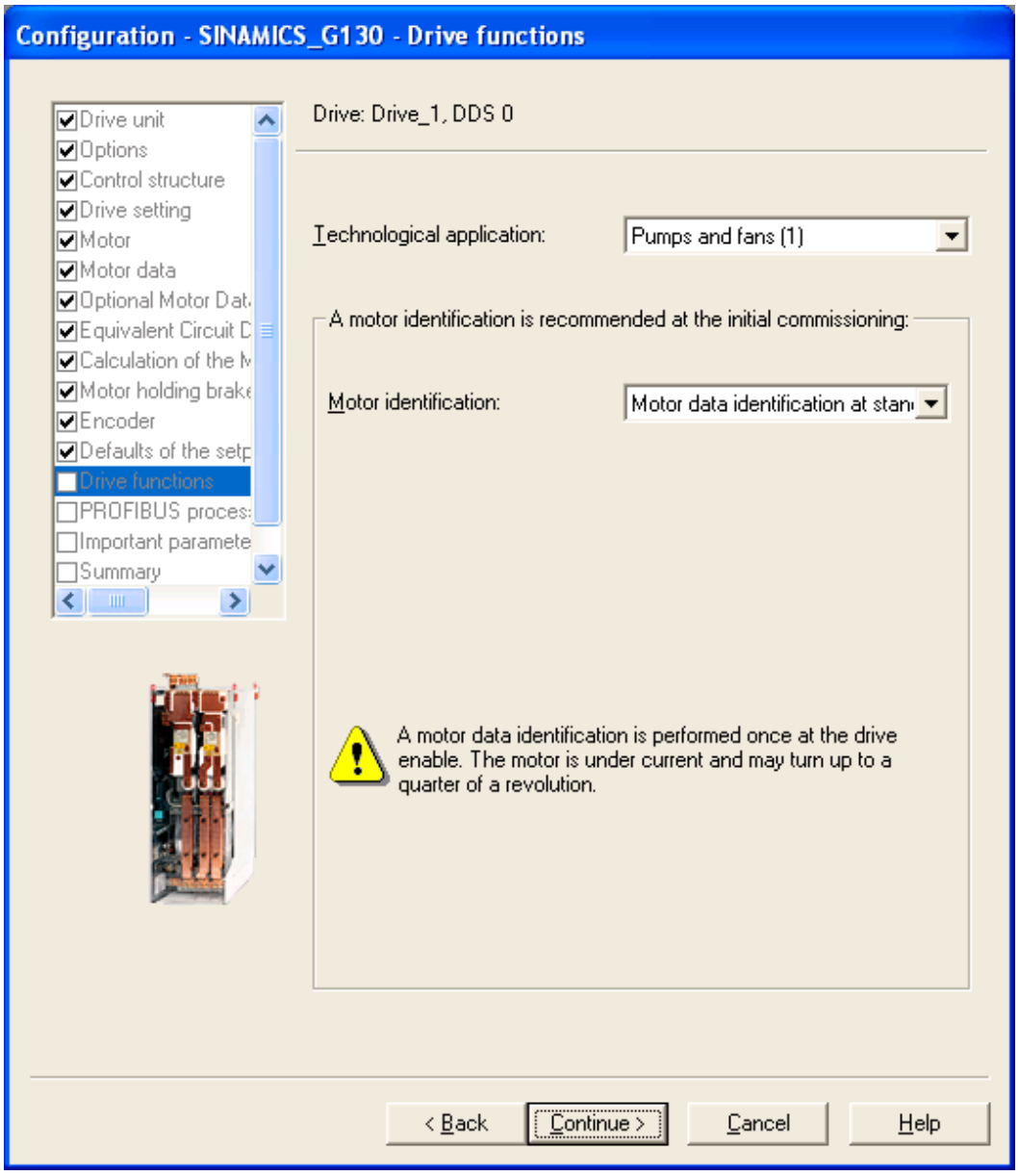


Figure 5-26 Defining the technological application/motor identification

36. Select the required data:

- **Technological application:**
  - "Pumps and fans": edge modulation is enabled (default setting)
  - "Standard drive (VECTOR)": edge modulation is not enabled.
- **Motor identification:**
  In most cases, "Motor data identification at standstill" is the appropriate default setting for SINAMICS G130.

37. Click **Continue >**.

Selecting the PROFIBUS message frame

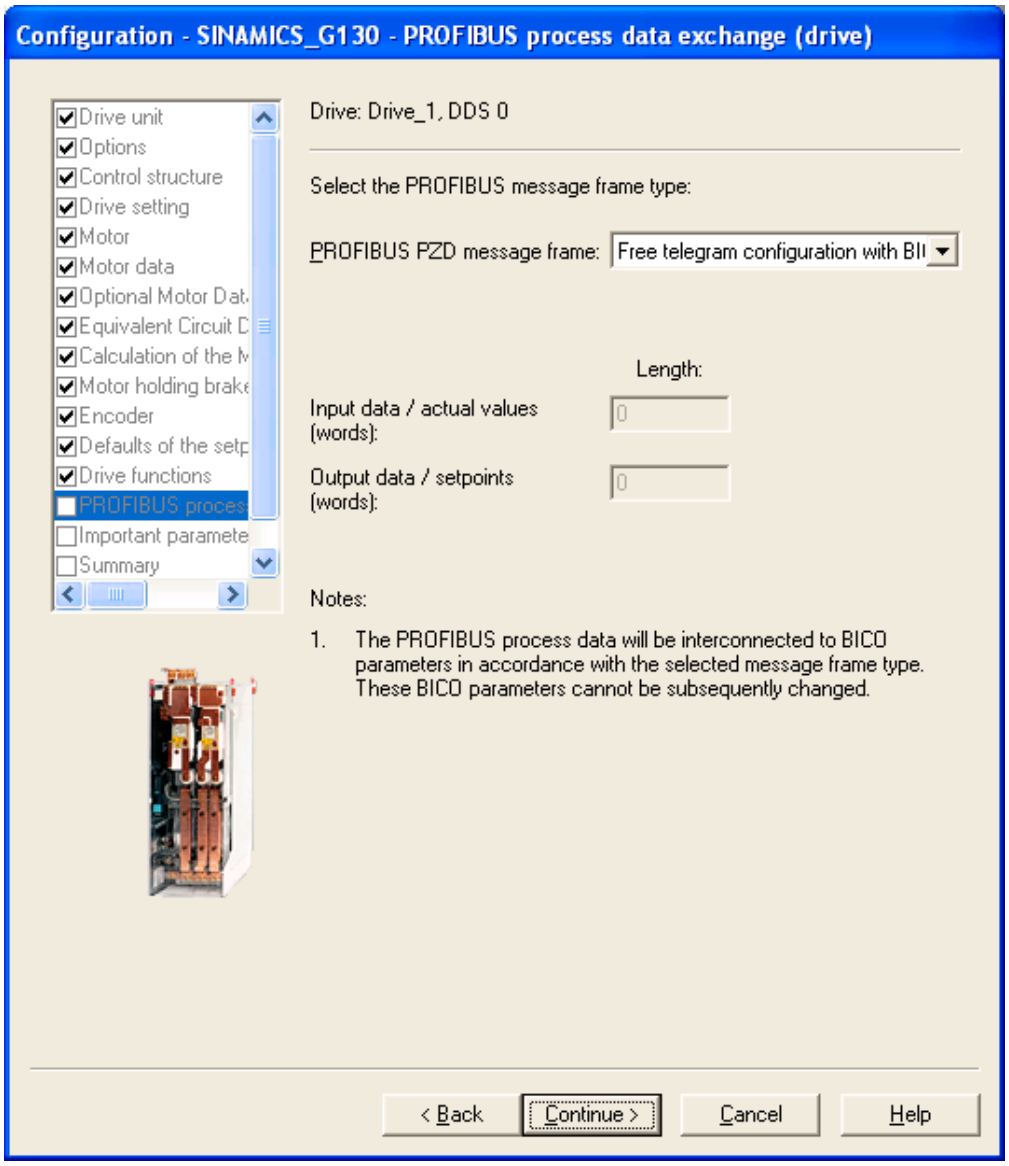


Figure 5-27 Selecting the PROFIBUS message frame

38. In the **PROFIBUS PZD message frame** field, select the PROFIBUS message frame type.

Message frame types

- Standard message frame 1
- Standard message frame 2
- Standard message frame 3
- Standard message frame 4
- VIK-NAMUR message frame 20
- PCS7 message frame 352
- Free message frame configuration with BICO

39. Click **Continue >**.

Entering important parameters

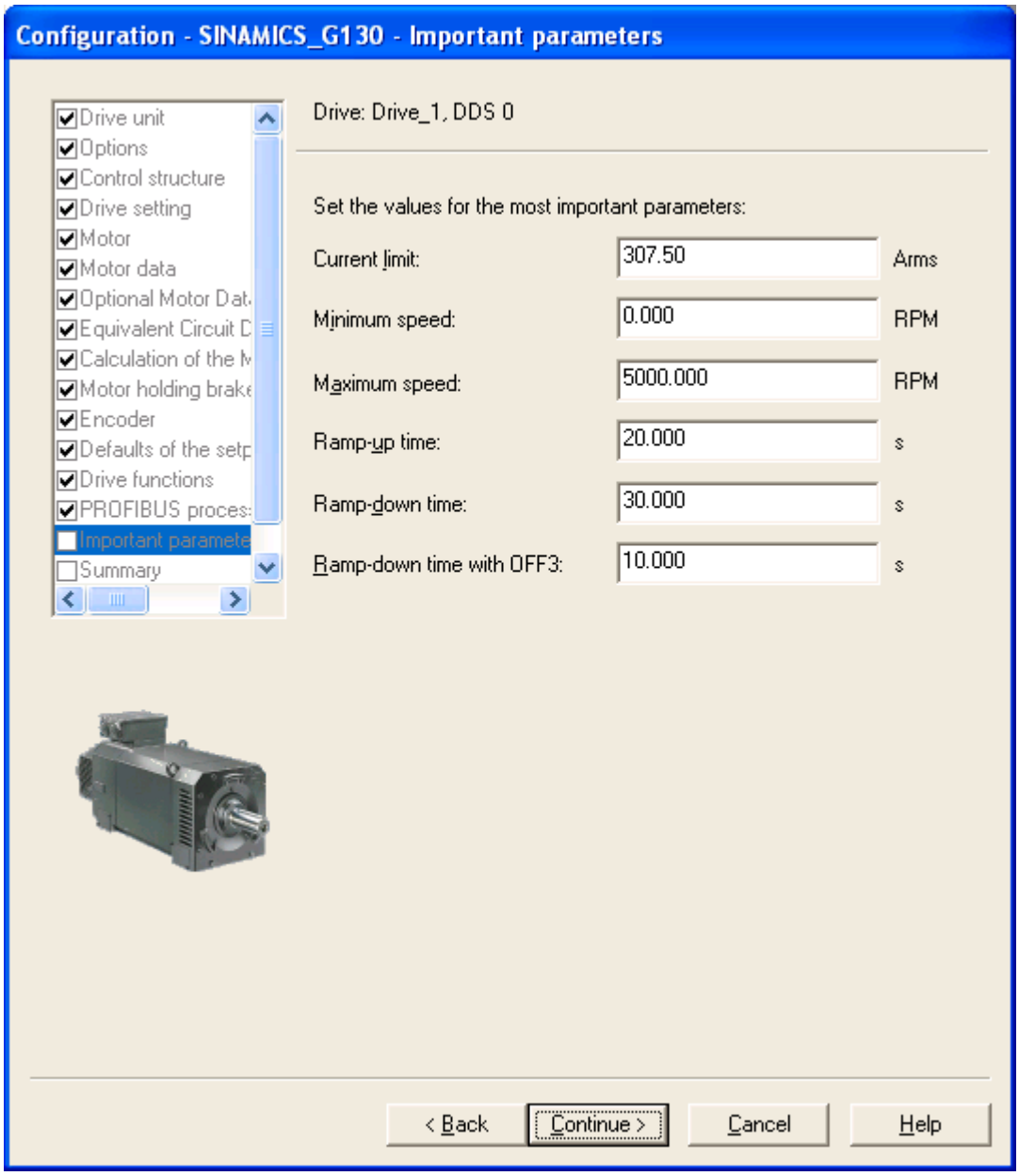


Figure 5-28 Important parameters

40. Enter the required parameter values.

Note

STARTER provides tool tips if you position your cursor on the required field **without clicking in the field**.

41. Click **Continue >**.

Summary of the drive unit data

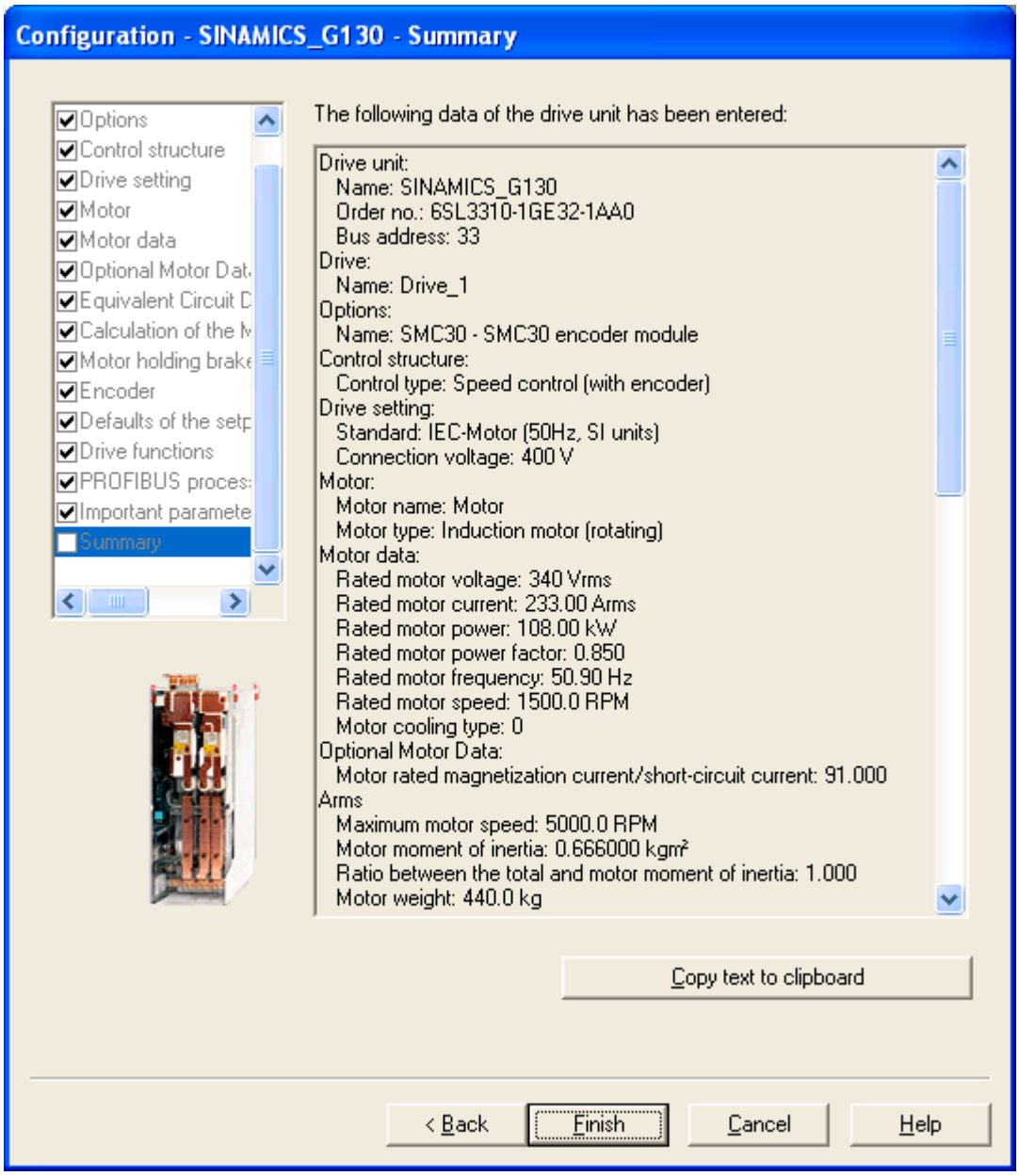


Figure 5-29 Summary of the drive unit data

42. You can use the **Copy text to clipboard** function to copy the summary of the drive unit data displayed on the screen to a word processing program so that you can edit it further.

43. Click **Finish**.

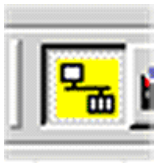
44. Save your project to the hard disk by choosing **Project > Save**.

5.3.3 Starting the drive project

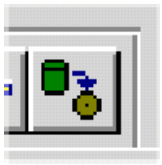
You have created a project and saved it to your hard disk. You now have to transfer your project configuration data to the drive unit.

Transferring the STARTER project to the drive unit

To transfer the STARTER project you created offline to the drive unit, carry out the following steps:

Step		Selection in toolbar
1	Choose **Project > Connect to target system**	
2	Choose **Target system > Load project to target system**	

NOTICE
The project has now been loaded to the drive unit. The data is currently only stored in the volatile memory of the drive unit and not on the CompactFlash card. To store the project data on the CompactFlash card so that it is protected in the event of a power failure, carry out the following step.

Step		Selection in toolbar
3	Choose **Target system > Copy from RAM to ROM**	

Note

The **Copy from RAM to ROM** icon is only active when the drive unit is selected in the project navigator.

Results of the previous steps

- You have created a drive unit project offline using STARTER.
- You have saved the project data to the hard disk on your PC.
- You have transferred the project data to the drive unit.
- You have saved the project data to the CompactFlash card so that it is protected in the event of a power failure.

Note

The STARTER commissioning tool supports complex drive system operations.

If you are confronted with any system conditions in online mode that are beyond your control, you are advised to delete the drive project from the project navigator and carefully create a new project in STARTER using the appropriate configuration data for your application.

5.3.4 Connection via serial interface

In addition to using the PROFIBUS connection, data can also be exchanged via a serial interface.

Requirement

The PC from which the connection is to be made must be equipped with a serial interface (COM).

Settings

1. In STARTER, choose **Project > Set PC/PG interface** and select the **serial cable (PPI)** interface.
   If this is not available from the dropdown list, you first have to add it by choosing **Select**.

   Note

   If the interface cannot be added to the selection menu, the driver for the serial interface has to be installed.
   This is located under the following path on the STARTER CD:
   \installation\starter\starter\Disk1\SerialCable_PPI\
   STARTER must not be active while the driver is being installed.

2. Make the following settings. The "0" address and the transmission rate of 19.2 kbit/s are important here.

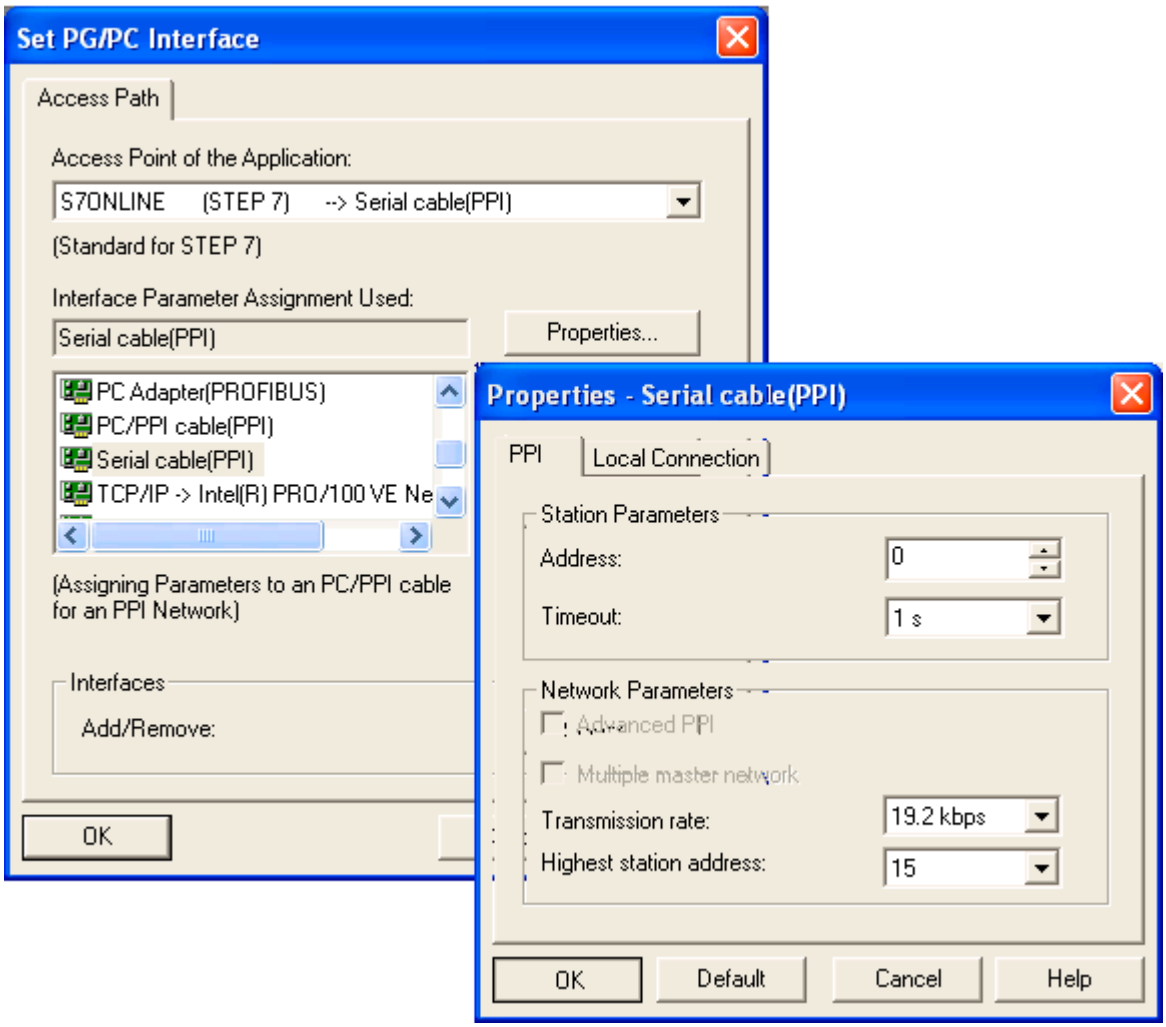


Figure 5-30 Setting the interface

3. On CU320, set bus address "3" on the Profibus address switch.
4. When creating the drive unit, also set bus address "3".

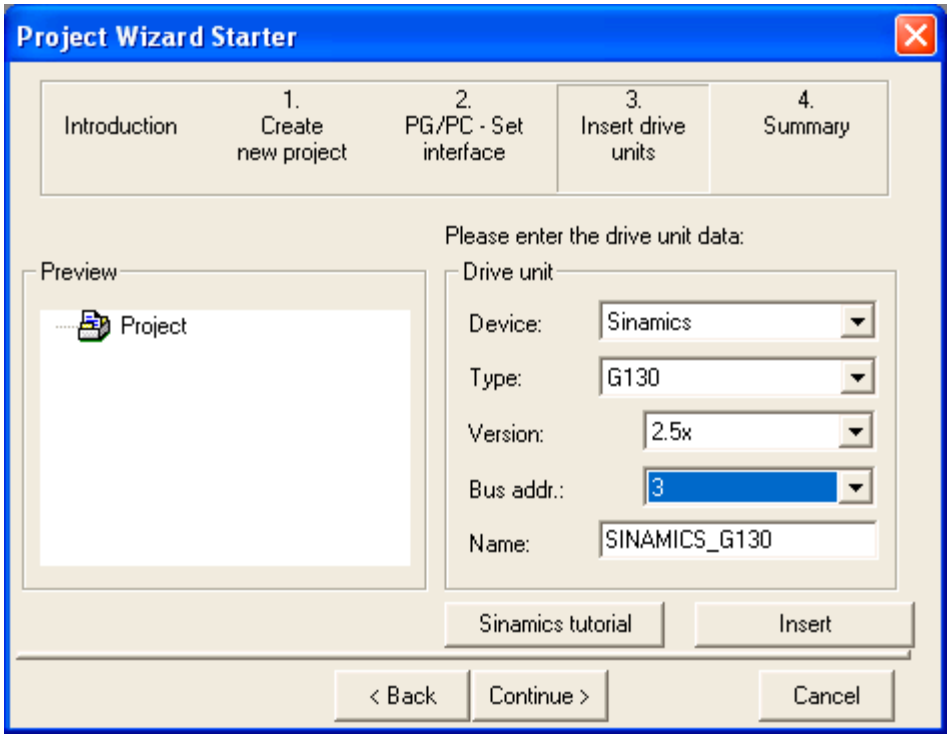


Figure 5-31 Setting the bus address

Note

The bus addresses on CU320 and on the PC must not be set the same.

5. The connecting cable from CU320 to AOP30 must be disconnected on CU320. A null modem cable must be used here to connect the PC (COM interface) and CU320. This interface must not be switched.

5.4 The AOP30 operator panel

Description

An optional operator panel for operating, monitoring, and commissioning purposes is available. It has the following features:

- Graphical, back-lit LCD for plain-text display and a "bar chart display" for process variables
- LEDs for indicating the operating modes
- Help function describing causes of and remedies for faults and alarms
- Keypad for controlling drives during operation
- LOCAL/REMOTE switchover for selecting the control terminal (master control assigned to operator panel or terminal block / PROFIBUS)
- Numeric keypad for entering setpoint or parameter values
- Function keys for prompted navigation through the menus
- Two-stage security concept to protect against accidental or unauthorized changes to settings
- Degree of protection IP 54 (when installed)

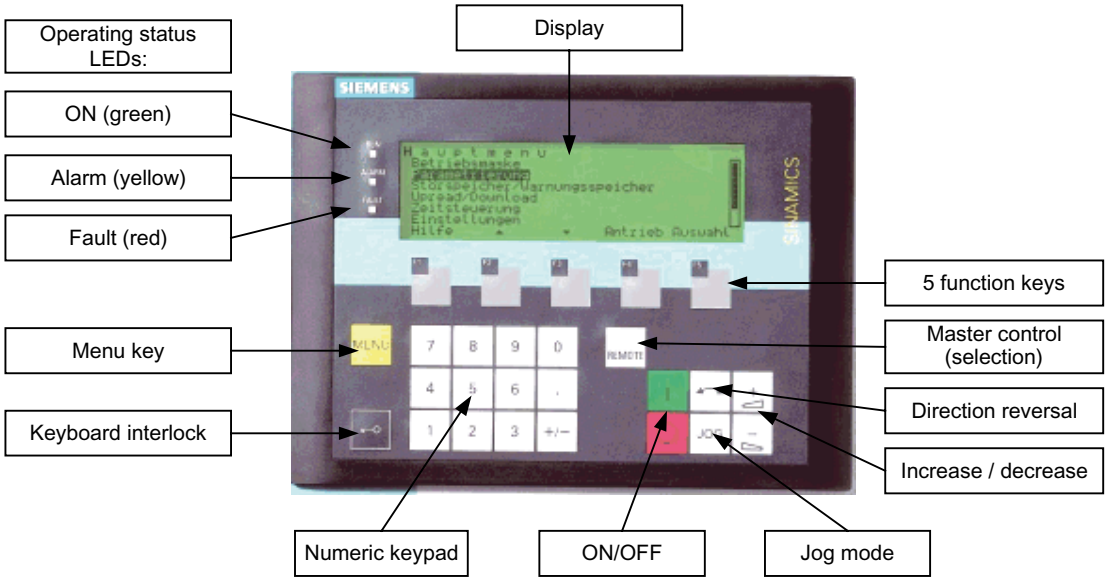


Figure 5-32 Components of the chassis unit operator panel (AOP30)

5.5 First commissioning

5.5.1 First commissioning

Start screen

When the system is switched on for the first time, the Control Unit (CU320) is initialized automatically. The following screen is displayed:

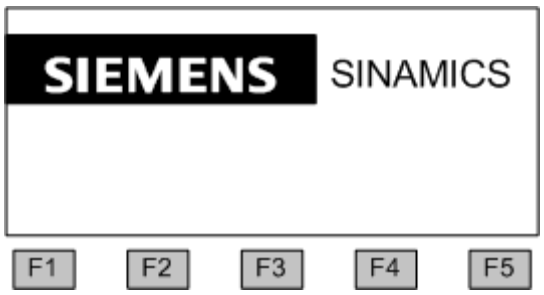


Figure 5-33 Initial screen

When the system boots up, the parameter descriptions are loaded into the operating field from the CompactFlash card.

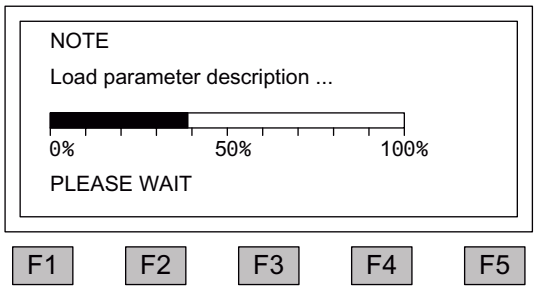
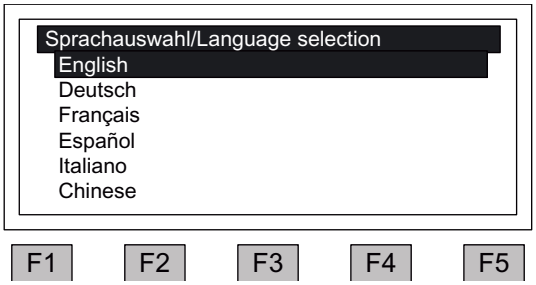


Figure 5-34 Load the parameter descriptions while booting up the system

Selecting the language

When the system is first booted up, a screen for selecting the language appears.



You can select the language in the dialog screen.

To change the language, choose <F2> or <F3>.
To select the language, choose <F5>.

Once the language has been selected, the booting up process continues.

Once the system has successfully ramped up, the drive has to be commissioned when the system is switched on for the first time after it has been delivered. The converter can then be switched on.

When the system is then ramped up again, it can be operated immediately.

Navigation within the interactive screens

Within an interactive screen, the selection boxes can usually be selected using the <F2> and/or <F3> keys. Selection fields are generally texts surrounded by a frame. When they are selected, they are highlighted with a white text on a black background.
The present value of a highlighted selection box can usually be changed by pressing <F5> "OK" and/or "Change". Another entry box then appears and the value you want is entered directly using the numerical keypad or can be selected from a list.

You can change from one interactive screen to the next or previous screen by selecting the "Next" or "Previous" selection boxes and then confirming by pressing <F5> "OK".
If a screen contains particularly important parameters, the selection field "Continue" only appears at the bottom of the screen. This is because every single parameter in this interactive screen has to be checked and/or corrected thoroughly before the next interactive screen can be accessed.

5.5.2 Basic commissioning

Entering the motor data

During initial commissioning, you have to enter motor data using the operator panel. Use the data shown on the motor type plate.

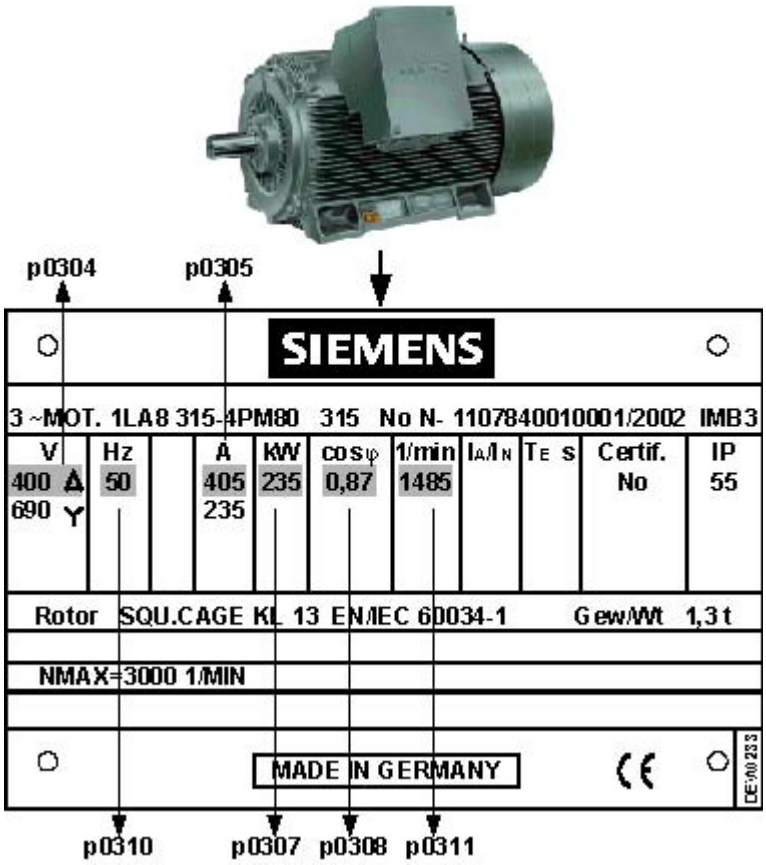
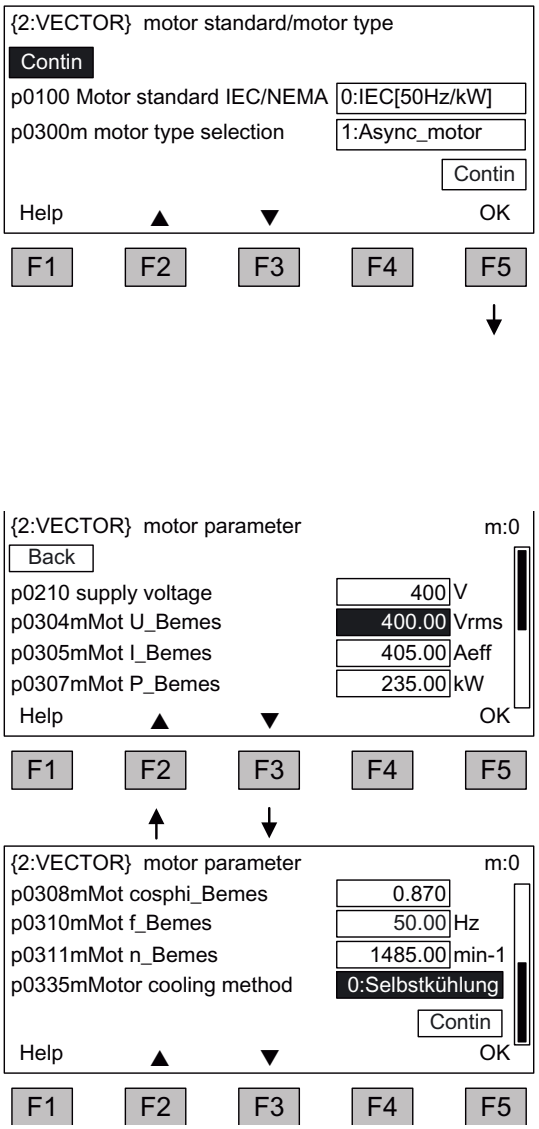


Figure 5-35 Example of a motor type plate

Table 5-1 Motor data

	Parameter no.	Values	Unit
System of units for line frequency and entering motor data	p0100	0 1	IEC [50 Hz / kW] NEMA [60 Hz / hp]
Motor: Rated voltage Rated current Rated output Rated power factor Cos (at p0100 = 0 only) Rated efficiency (at p0100 = 1 only) Rated frequency Rated speed	 p0304 p0305 p0307 p0308 p0309 p0310 p0311		 [V] [A] [kW] / [hp] [%] [Hz] [min-1] / [rpm]

Basic commissioning: Selecting the motor type and entering the motor data



You can select the motor standard and type in the dialog screen.

The following is defined for the motor standard:

0: Line frequency 50 Hz, motor data in kW
1: line frequency 60 Hz, motor data in hp

The following selection options are available for the motor type:

1: Induction motor
2: Permanent-magnet synchronous motor
Other values are not permitted.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Entering motor data specified on the type plate

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

The system displays another window in which you can:

- Enter the value directly, or
- select the value from a list.

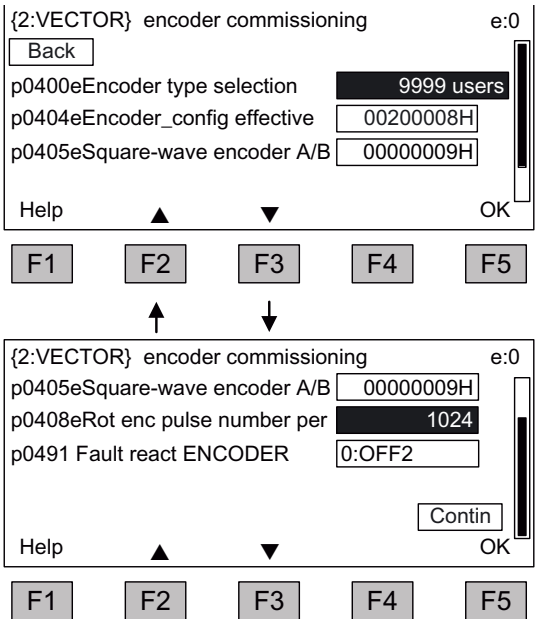
When you have finished entering the motor data, choose "Continue" underneath the final parameter value and activate your entries with <F5>.

Note

The steps described below also apply to induction motors.

When commissioning a permanent-magnet synchronous motor (p0300 = 2), there are a few special conditions, which are detailed in a separate chapter (see "Setpoint channel and closed-loop control/Permanent-magnet synchronous motors").

Basic commissioning: entering the encoder data (if available)



When the SMC30 is connected for encoder evaluation, it is recognized by the AOP30 and a screen is displayed in which you can enter the encoder data.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Predefined encoders can be easily set by selecting parameter p0400 (encoder type selection):

3001:	1024 HTL A/B R at X521/X531
3002:	1024 TTL A/B R at X521/X531
3003:	2048 HTL A/B R at X521/X531
3005:	1024 HTL A/B at X521/X531
3006:	1024 TTL A/B at X521/X531
3007:	2048 HTL A/B at X521/X531
3008:	2048 TTL A/B at X521/X531
3009	1024 HTL A/B unipolar at X521/X531
3011:	2048 HTL A/B unipolar at X521/X531
3020:	2048 TTL A/B R with sense to X520

Note

In the factory setting, an HTL encoder is bipolar with 1024 pulses per revolution and a 24 V power supply.

The section ("Electrical Installation") contains two connection examples for HTL and TTL encoders.

Note

If the connected encoder does not match any of the encoders predefined in p0400, follow the simple procedure below for entering the encoder data:

- Via p0400, select an encoder type whose data is similar to that of the connected encoder.
- Select "User-defined encoders" (p0400 = 9999). Previously set values are stored here.
- Adjust the bit fields of p0404, p0405, and p0408 to the data for the connected encoder.

Table 5-2 Meaning of the bit setting for p0404

Bit	Meaning	Value 0	Value 1
20	Voltage 5 V	No	yes
21	Voltage 24 V	No	yes

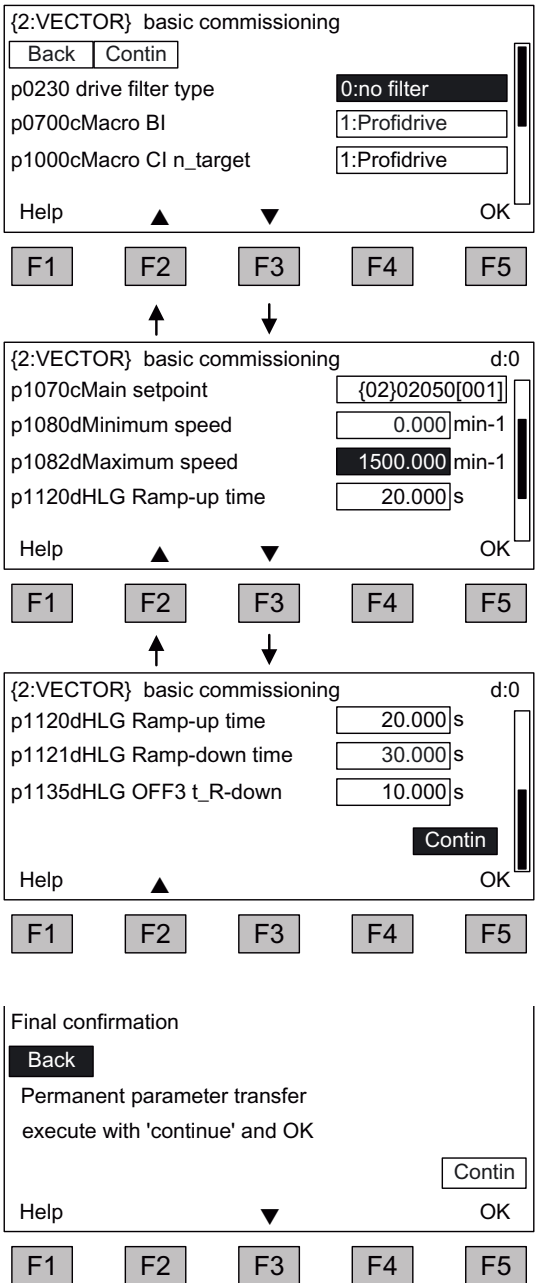
Table 5-3 Meaning of the bit settings for p0405

Bit	Meaning	Value 0	Value 1
0	Signal	Unipolar	Bipolar
1	Level	HTL	TTL
2	Track monitoring	None	A/B>< -A/B
3	Zero pulse	24 V unipolar	Same as A/B track

CAUTION

Once the encoder has been commissioned, the supply voltage (5/24 V) set for the encoder is activated on the SMC30 module. If a 5 V encoder is connected and the supply voltage has not been set correctly via p0404 (bit 20 = "Yes", bit 21 = "No"), the encoder may be damaged.

Basic commissioning: Entering the basic parameters



Entering the basic commissioning parameters:
If a sine-wave filter is connected, it must be activated in p0230 (p0230 = 3/4). Otherwise, it could be destroyed.

p0700: Preset command source
1: PROFIdrive
2: TM31 terminals
3: CU terminals
4: PROFIdrive+TM31

p1000: Preset setpoint source
1: PROFIdrive
2: TM31 terminals
3: Motorized potentiometer
4: Fixed setpoint

Once a setpoint source has been selected (p1000), the main setpoint p1070 is defaulted accordingly.

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

To change a parameter value, navigate to the required selection field and activate with <F5>.

Another window appears in which you can
- enter the required value directly, or
- select the value from a list.

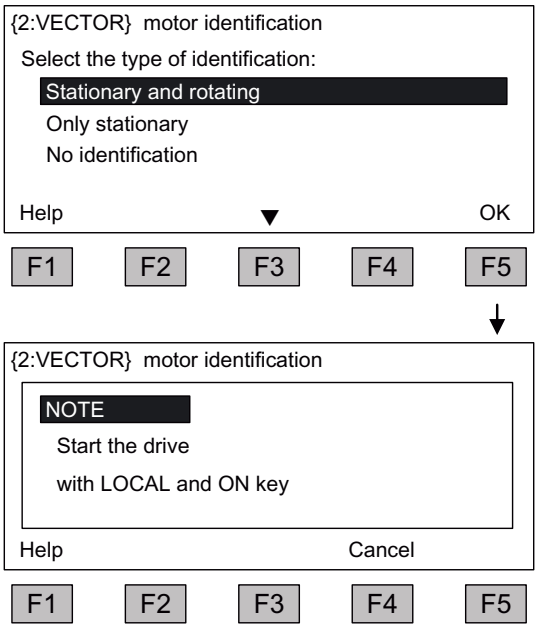
Final confirmation

Confirm the basic parameters to save them.

Once you have selected "Continue" and activated your entries with <F5>, the basic parameters you entered are permanently saved and the calculations required for closed-loop control are carried out.

NOTICE
A filter on the motor side must be entered in p0230 (motor reactor: p0230 = 1, dV/dt filter with Voltage Peak Limiter: p0230 = 2, Siemens sine-wave filter: p0230 = 3, third-party sine-wave filter: p0230 = 4), otherwise motor control does not function properly.

Basic commissioning: Motor identification



Selecting motor identification

To navigate through the selection fields, choose <F2> or <F3>.
To activate a selection, choose <F5>.

Stationary measurement increases the control performance as deviations in the electrical characteristic values are minimized on account of deviations in the material properties and manufacturing tolerances.

Rotary measurement determines the data required (e.g. moment of inertia) for setting the speed controller. It also measures the magnetization characteristic and rated magnetization current of the motor.

To activate this function, press the LOCAL key (wait until the LED in the LOCAL key lights up) and then ON.

If motor identification is not carried out, the motor control uses the motor characteristic values calculated from the type plate data rather than the measured values.

⚠DANGER

When the the rotating measurement is selected, the drive triggers movements in the motor that can reach the maximum motor speed. The emergency OFF functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be carefully observed.

Note

If a fault is present when selecting the stationary or rotary measurement, motor identification cannot be carried out.
Before rectifying the fault, you have to leave the screen with "No identification".
Motor identification can then be selected again via <MENU> - <Commissioning/service> - <Drive commissioning> - <Motor identification>.

5.6 Status after commissioning

LOCAL mode (control via operator panel)

- You switch to LOCAL mode by pressing the "LOCAL/REMOTE" key.
- Control (ON/OFF) is carried out via the "ON" and "OFF" keys.
- You can specify the setpoint using the "increase" and "decrease" keys or by entering the appropriate numbers using the numeric keypad.

Analog outputs (for version with TM31)

- The actual speed (r0063) is output as a voltage output in the range 0 to 10 V at analog output 0 (X522:1 and 2).
  10 V is equal to the maximum speed in p1082.
- The actual current value (r0068) is output as a voltage output in the range 0 to 10 V at analog output 1 (X522:4 and 5).
  10 V corresponds to the current limit (p0640), which is set to 1.5 x the rated motor current (p0305).

Digital outputs (for version with TM31)

- The "enable pulses" signal is output at digital output 0 (X542:2 and 3).
- The “no fault active” signal is output at digital output 1 (X542:5 and 6) (protection against wire breakage).
- The "ready to start" signal is output at digital output 8 (X541:2).

5.7 Parameter reset to factory settings

The factory settings represent the defined original status of the device on delivery.

Resetting the parameters to the factory settings means that all the parameter settings made since the system was delivered are reset.

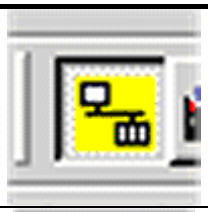
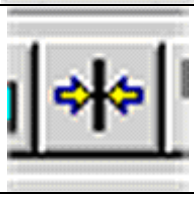
Resetting Parameters via AOP30

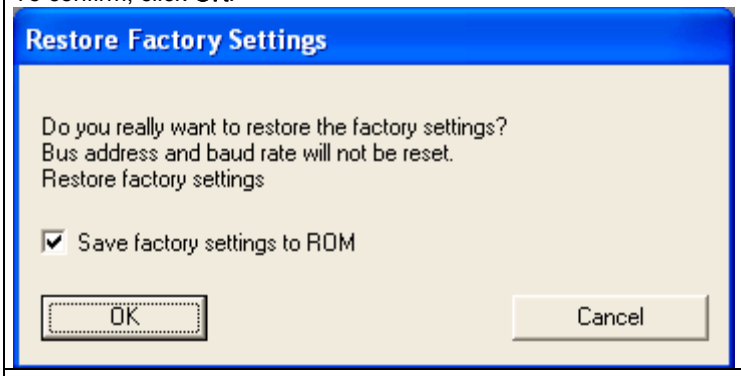
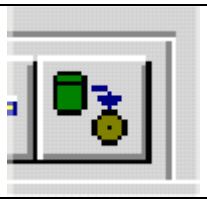
Table 5-4 Procedure for resetting parameters to the factory settings with AOP30

"Advanced" access level ↓ Select parameter reset ↓ Press OK	**Setting the "Extended" access level on the operator panel** <Key pushbutton> - <Access level> - Set "Extended" **Setting the parameter filter to "Parameter reset"** <MENU> <Commissioning/Service> <Device commissioning> <OK> <30: Parameter Reset> <OK> **Reset all parameters to factory settings** The factory settings for all the device parameters are restored.

Parameter reset via STARTER

With STARTER, the parameters are reset in online mode. The required steps are described below:

Step	Selection in toolbar
Choose **Project > Connect to target system**	
Click the drive unit whose parameters you want to reset to the factory settings and click **Restore factory settings** icon in the toolbar.	

Step	Selection in toolbar
To confirm, click **OK**. 	
Choose **Target system > Copy from RAM to ROM**	

Note

The **Copy from RAM to ROM** icon is only active when the drive unit is selected in the project navigator.

When the parameters have been reset to the factory settings, initial commissioning needs to be carried out.

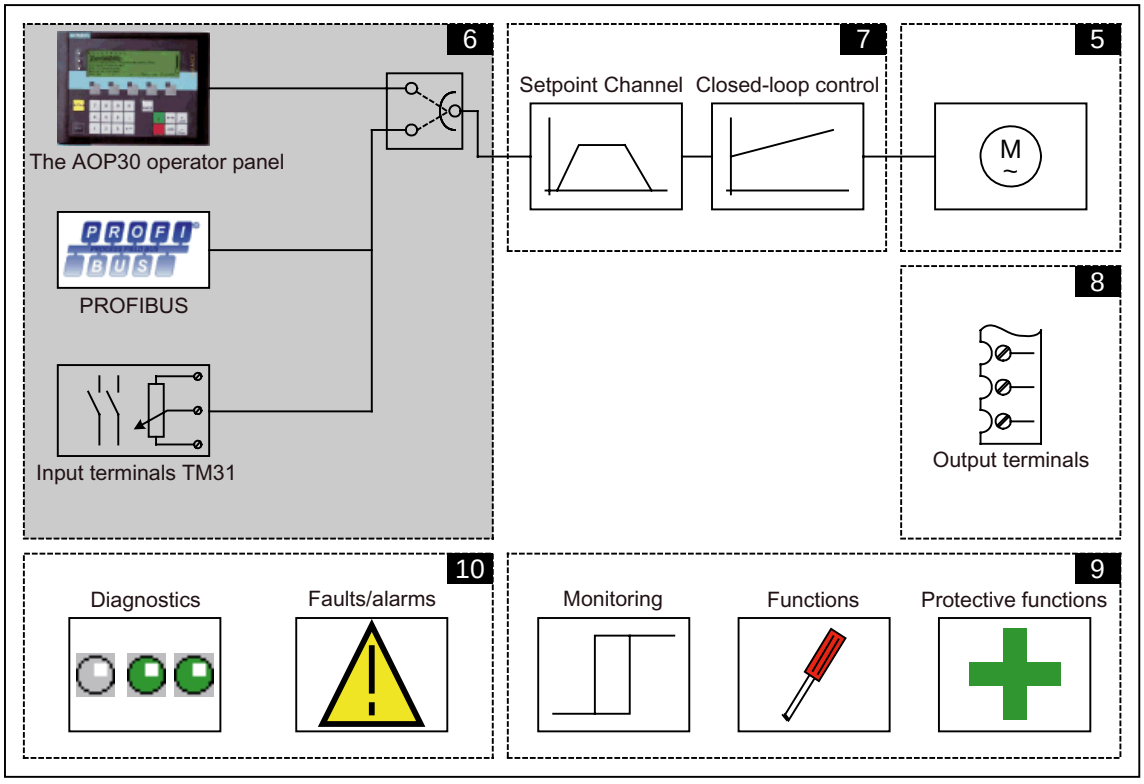
Operation

6

6.1 Chapter content

This chapter provides information on the following:

- Basic information about the drive system
- Selecting command sources via:
  - PROFIdrive
  - TM31 terminal block
  - CU320 terminal block
- Specifying setpoints via:
  - PROFIdrive
  - Analog inputs
  - Motorized potentiometer
  - Fixed setpoints



6.2 General information about command and setpoint sources

Description

Four default settings are available for selecting the command sources and four for selecting the setpoint sources for the SINAMICS G130.

Command sources

- Profidrive
- TM31 terminals
- CU terminals
- Profidrive+TM31

Setpoint sources

- Profidrive
- Analog inputs
- Motorized potentiometer
- Fixed setpoints

The various assignments are explained in the following sections.

Note

Make sure that the default settings you choose during commissioning are compatible with the system configuration (for more information, see "Commissioning").

Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle of the SINAMICS G130.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (6xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD in the "SINAMICS G List Manual", which provides experienced users with detailed descriptions of all the functions.

6.3 Basic information about the drive system

6.3.1 Parameters

Overview

The drive is adapted to the relevant drive task by means of parameters. Each parameter is identified by a unique parameter number and by specific attributes (e.g. read, write, BICO attribute, group attribute, and so on).

The parameters can be accessed via the following means:

- PC with the "STARTER" commissioning tool via PROFIBUS
- The user-friendly AOP30 Operator Panel

Parameter types

The following adjustable and visualization parameters are available:

- Adjustable parameters (write/read)

  These parameters have a direct impact on the behavior of a function.

  Example: Ramp-up and ramp-down time of a ramp-function generator
- Visualization parameters (read-only)

  These parameters are used to display internal variables.

  Example: current motor current

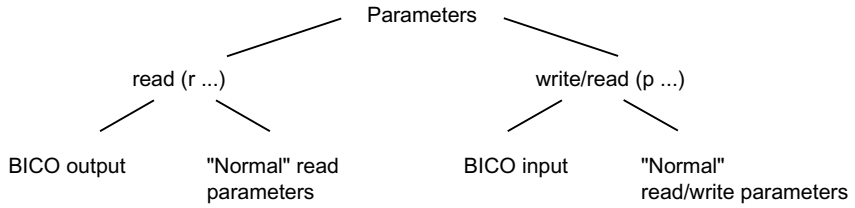


Figure 6-1 Parameter types

All these drive parameters can be read and changed via PROFIBUS using the mechanisms defined in the PROFIdrive profile.

Parameter categories

The parameters for the individual drive objects (see "Drive objects") are categorized according to data sets as follows (see "Operation/data sets"):

- Data-set-independent parameters
  These parameters exist only once per drive object.
- Data-set-dependent parameters
  These parameters can exist several times for each drive object and can be addressed via the parameter index for reading and writing. A distinction is made between various types of data set:
  - CDS: Command data set
    By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.
  - DDS: Drive Data Set
    The drive data set contains the parameters for switching between different drive control configurations.

  The CDS and DDS can be switched over during normal operation. Further types of data set also exist, however these can only be activated indirectly by means of a DDS switchover.

  - EDS: encoder data set
  - MDS: Motor data set

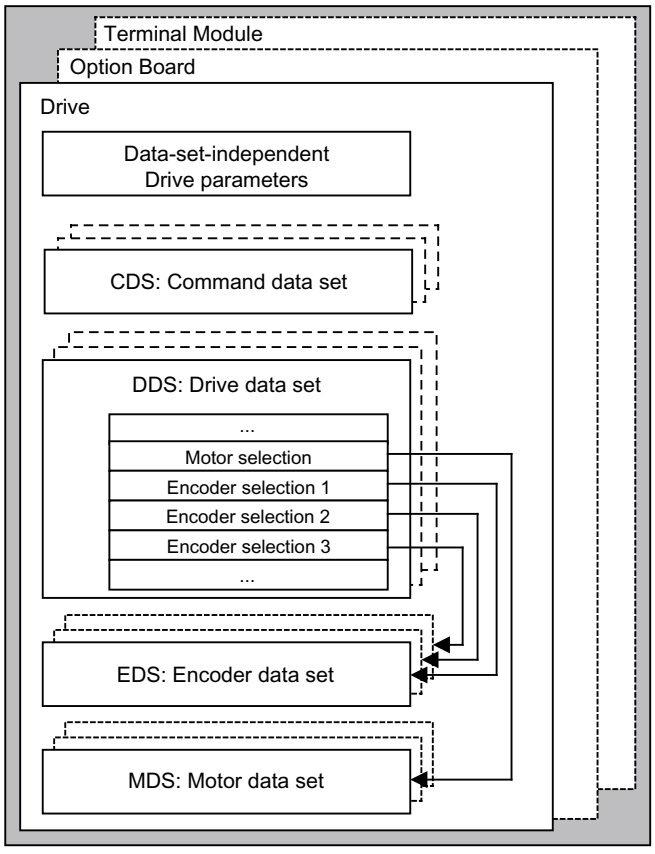


Figure 6-2 Parameter categories

6.3.2 Drive objects

A drive object is a self-contained software function with its own parameters and, if necessary, its own faults and alarms. Drive objects can be provided as standard (e.g. I/O evaluation), or you can add single (e.g. option board) or multiple objects (e.g. drive control).

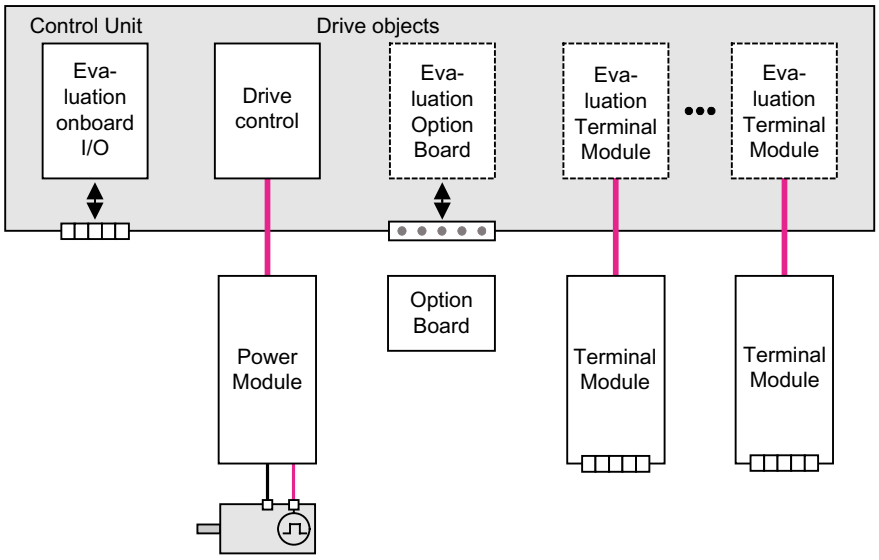


Figure 6-3 Drive objects

Drive objects available as standard

- Drive control
  Drive control handles closed-loop control of the motor. One Power Module, at least one motor, and up to three sensors are assigned to drive control.
- Control Unit, inputs/outputs
  The inputs/outputs on the Control Unit are evaluated within a drive object. High-speed inputs for probes are processed here in addition to bidirectional digital I/Os.

Properties of a drive object

- Separate parameter space
- Separate window in STARTER
- Separate fault/alarm system
- Separate PROFIdrive telegram for process data

Optionally installed drive objects

- Option board evaluation

  A further drive object handles evaluation of an installed option board. The specific method of operation depends on the type of option board installed.

- Terminal Module evaluation

  A separate drive object handles evaluation of the respective optional Terminal Modules.

Configuring drive objects

When you commission the system for the first time using the STARTER tool, you will use configuration parameters to set up the software-based "drive objects" which are processed on the Control Unit. Various drive objects can be created within a Control Unit.

The drive objects are configurable function blocks and are used to execute specific drive functions.

If you need to configure additional drive objects or delete existing ones after initial commissioning, the drive system must be switched to configuration mode.

The parameters of a drive object cannot be accessed until the drive object has been configured and you have switched from configuration mode to parameterization mode.

Note

Each installed drive object is allocated a number between 0 and 63 during initial commissioning for unique identification.

Parameters

- p0101 Drive object numbers
- r0102 Number of drive objects
- p0107 Drive object type
- p0108 Drive object configuration

6.3.3 Data sets

Description

For many applications, it is beneficial if more than one parameter can be changed simultaneously by means of **one** external signal during operation/when the system is ready for operation.

This can be carried out using indexed parameters, whereby the parameters are grouped together in a data set according to their functionality and indexed. Indexing allows several different settings, which can be activated by switching the data set, to be defined in each parameter.

Note

The command and drive data sets can be copied in STARTER (Drive -> Configuration -> "Command data sets" or "Drive data sets" tab).
The displayed command and drive data sets can be selected in the associated STARTER screen forms..

CDS: Command data set

The BICO parameters (binector and connector inputs) are grouped together in a command data set. These parameters are used to interconnect the signal sources of a drive (see "Operation/BICO technology: Interconnecting signals").

By parameterizing several command data sets and switching between them, the drive can be operated with different pre-configured signal sources.

A command data set contains the following (examples):

- Binector inputs for control commands (digital signals)
  - ON/OFF, enable signals (p0844, etc.)
  - Jog (p1055, etc.)
- Connector inputs for setpoints (analog signals)
  - Voltage setpoint for V/f control (p1330)
  - Torque limits and scaling factors (p1522, p1523, p1528, p1529)

Two command data sets are available.

The following parameters are available for selecting command data sets and for displaying the currently selected command data set:

Table 6-1 Command data set: selection and display

CDS	Select bit 0 p0810	Display	
		selected (r0836)	active (r0050)
0	0	0	0
1	1	1	1

If a command data set, which does not exist, is selected, the current data set remains active.

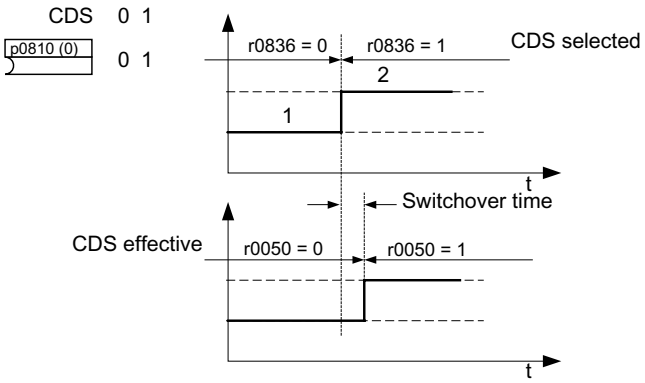


Figure 6-4 Example: Switching between command data set 0 and 1

DDS: Drive data set

A drive data set contains various adjustable parameters that are relevant with respect to open and closed-loop drive control:

- Numbers of the assigned motor and encoder data sets:
  - p0186: assigned motor data set (MDS)
  - p0187 to p0189: up to 3 assigned encoder data sets (EDS)
- Various control parameters, e.g.:
  - Fixed speed setpoints (p1001 to p1015)
  - Speed limits min./max. (p1080, p1082)
  - Characteristic data of ramp-function generator (p1120 ff)
  - Characteristic data of controller (p1240 ff)
  - ...

The parameters that are grouped together in the drive data set are identified in the SINAMICS parameter list by "Data Set DDS" and are assigned an index [0..n].

It is possible to parameterize several drive data sets. You can switch easily between different drive configurations (control type, motor, encoder) by selecting the corresponding drive data set.

One drive object can manage up to 32 drive data sets. The number of drive data sets is configured with p0180.

Binector inputs p0820 to p0824 are used to select a drive data set. They represent the number of the drive data set (0 to 31) in binary format (where p0824 is the most significant bit).

- p0820 BI: Drive data set selection DDS bit 0
- p0821 BI: Drive data set selection DDS bit 1
- p0822 BI: Drive data set selection DDS bit 2
- p0823 BI: Drive data set selection DDS bit 3
- p0824 BI: Drive data set selection DDS, bit 4

Supplementary conditions and recommendations

- Recommendation for the number of DDS in a drive
  The number of DDS in a drive should correspond with the number of switchover options; in other words
  p0180 (DDS) ≥ p0130 (MDS).
- Max. number of DDS for one drive object = 32 DDS

EDS: Encoder data set

An encoder data set contains various adjustable parameters describing the connected encoder for the purpose of configuring the drive.

- Adjustable parameters, e.g.:
  - Encoder interface component number (p0141)
  - Encoder component number (p0142)
  - Encoder type selection (p0400)

The parameters that are grouped together in the encoder data set are identified in the SINAMICS parameter list by "Data Set EDS" and are assigned an index [0..n].

A separate encoder data set is required for each encoder controlled by the Control Unit. Up to 3 encoder data sets are assigned to a drive data set via parameters p0187, p0188, and p0189.

An encoder data set can only be changed using a DDS changeover.

Each encoder may only be assigned to one drive and within a drive must - in each drive data set - either always be encoder 1, always encoder 2 or always encoder 3.

One application for the EDS changeover would be a power component with which several motors are operated in turn. A contactor circuit is used to changeover between these motors. Each of the motors can be equipped with an encoder or be operated without an encoder (sensorless). Each encoder must be connected to its own SMx.

If encoder 1 (p0187) is changed over via DDS, then an MDS must also be changed over.

One drive object can manage up to 16 encoder data sets. The number of encoder data sets configured is specified in p0140.

When a drive data set is selected, the assigned encoder data sets are selected automatically.

MDS: Motor data set

A motor data set contains various adjustable parameters describing the connected motor for the purpose of configuring the drive. It also contains certain visualization parameters with calculated data.

- Adjustable parameters, e.g.:
  - Motor component number (p0131)
  - Motor type selection (p0300)
  - Rated motor data (p0304 ff)
  - ...
- Visualization parameters, e.g.:
  - Calculated rated data (p0330 ff)
  - ...

The parameters that are grouped together in the motor data set are identified in the SINAMICS parameter list by "Data Set MDS" and are assigned an index [0..n].

A separate motor data set is required for each motor that is controlled by the Control Unit via a Motor Module. The motor data set is assigned to a drive data set via parameter p0186.

A motor data set can only be changed using a DDS changeover.

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Changing-over between different windings in a motor (e.g. star-delta changeover)
- Motor data adaptation

If several motors are operated alternately on one Motor Module, a corresponding number of drive data sets must be created. See "Functions / Drive functions" for additional information and instructions on changing over motors.

One drive object can manage up to 16 motor data sets. The number of motor data sets in p0130 may not exceed the number of drive data sets in p0180.

Example of data set assignment

Table 6-2 Example, data set assignment

DDS	Motor (p0186)	Encoder 1 (p0187)	Encoder 2 (p0188)	Encoder 3 (p0189)
DDS 0	MDS 0	EDS 0	EDS 1	EDS 2
DDS 1	MDS 0	EDS 0	EDS 3	--
DDS 2	MDS 0	EDS 0	EDS 4	EDS 5
DDS 3	MDS 1	EDS 0	--	--

Copying the command data set (CDS)

Set parameter p0809 as follows:

1. p0809[0] = number of the command data set to be copied (source)
2. p0809[1] = number of the command data to which the data is to be copied (target)
3. p0809[2] = 1

Start copying.

Copying is finished when p0809[2] = 0.

Copying the drive data set (DDS)

Set parameter p0819 as follows:

1. p0819[0] = Number of the drive data set to be copied (source)
2. p0819[1] = Number of the drive data set to which the data is to be copied (target)
3. p0819[2] = 1

Start copying.

Copying is finished when p0819[2] = 0.

Copy motor data set (MDS)

Set parameter p0139 as follows:

1. p0139[0] = Number of the motor data set that is to be copied (source)
2. p0139[1] = Number of the motor data set which should be copied into (target)
3. p0139[2] = 1

Start copying.

Copying has been completed, if p0139[2] = 0.

Function diagram

FP 8560	Command Data Sets (CDS)
FP 8565	Drive Data Set (DDS)
FP 8570	Encoder data set (EDS)
FP 8575	Motor Data Sets (MDS)

Parameters

- p0120 Power Module data sets (PDS) number
- p0130 Motor data sets (MDS) number
- p0139[0...2] Copy motor data set (MDS)
- p0140 Encoder data sets (EDS) number
- p0170 Command data set (CDS) number
- p0180 Drive data set (DDS) number
- p0186 Assigned motor data set (MDS)
- p0187[0...n] Encoder 1 encoder data set number
- p0188[0...n] Encoder 2 encoder data set number
- p0189[0...n] Encoder 3 encoder data set number
- p0809 Copy command data set CDS
- p0810 BI: Command data set selection CDS bit 0
- p0811 BI: Command data set selection CDS bit 1
- p0812 BI: Command data set selection CDS bit 2
- p0813 BI: Command data set selection CDS bit 3
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection, bit 0
- p0821 BI: Drive data set selection, bit 1
- p0822 BI: Drive data set selection, bit 2
- p0823 BI: Drive data set selection, bit 3
- p0824 BI: Drive data set selection, bit 4

6.3.4 BICO technology: interconnecting signals

Description

Every drive contains a large number of interconnectable input and output variables and internal control variables.

BICO technology (Binector Connector Technology) allows the drive to be adapted to a wide variety of conditions.

Digital and analog signals, which can be connected freely by means of BICO parameters, are identified by the prefix BI, BO, CI or CO in their parameter name. These parameters are identified accordingly in the parameter list or in the function diagrams.

Note

The STARTER parameterization and commissioning tool is recommended when using BICO technology.

Binectors, BI: binector input, BO: Binector output

A binector is a digital (binary) signal without a unit which can assume the value 0 or 1.

Binectors are subdivided into binector inputs (signal sink) and binector outputs (signal source).

Table 6-3 Binectors

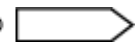
Abbreviation and symbol	Name	Description
BI	Binector input Binector Input (signal sink)	Can be interconnected to a binector output as source. The number of the binector output must be entered as a parameter value.
BO	Binector output Binector output (signal source)	Can be used as a source for a binector input.

Connectors, CI: connector input, CO: connector output

A connector is a digital signal e.g. in 32–bit format. It can be used to emulate words (16 bits), double words (32 bits) or analog signals. Connectors are subdivided into connector inputs (signal sink) and connector outputs (signal source).

The options for interconnecting connectors are restricted to ensure that performance is not adversely affected.

Table 6-4 Connectors

Abbreviation and symbol	Name	Description
CI	Connector input Connector input (signal sink)	Can be interconnected to a connector output as source. The number of the connector output must be entered as a parameter value.
CO 	Connector output Connector output (signal source)	Can be used as a source for a connector input.

Interconnecting signals using BICO technology

To interconnect two signals, a BICO input parameter (signal sink) must be assigned to the desired BICO output parameter (signal source).

The following information is required in order to connect a binector/connector input to a binector/connector output:

- Binectors: Parameter number, bit number, and drive object ID
- Connectors with no index: Parameter number and drive object ID
- Connectors with index: Parameter number, index, and drive object ID

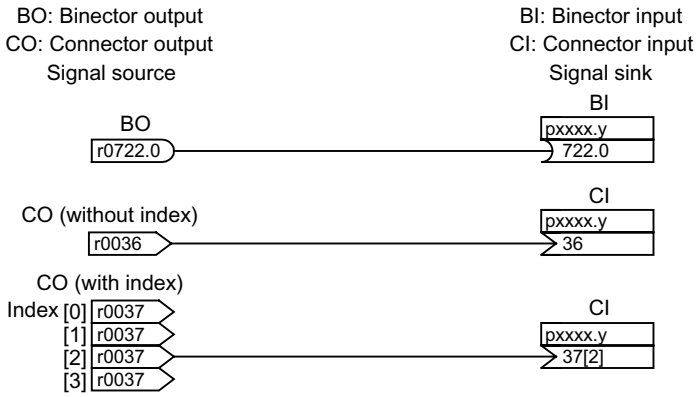


Figure 6-5 Interconnecting signals using BICO technology

Note

A signal source (BO) can be connected to any number of signal sinks (BI).

A signal sink (BI) can only ever be connected to one signal source (BO).

The BICO parameter interconnection can be implemented in different command data sets (CDS). The different interconnections are activated by switching data sets. Interconnections across drive objects are also possible.

Internal encoding of the binector/connector output parameters

The internal codes are needed, for example, to write BICO input parameters via PROFIdrive.

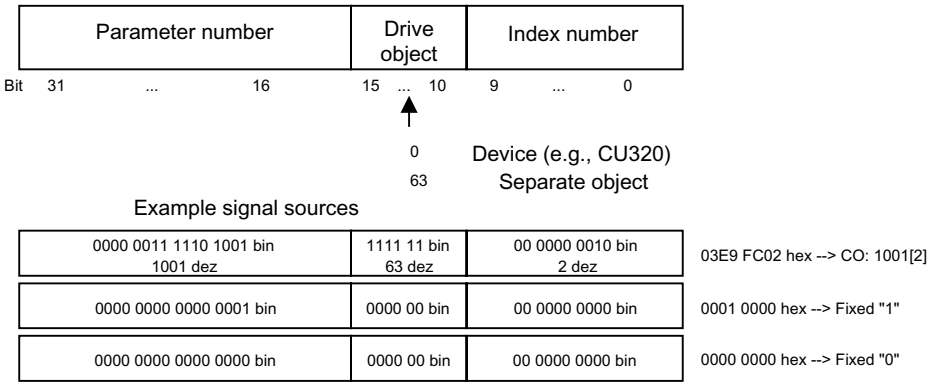


Figure 6-6 Internal encoding of the binector/connector output parameters

Example 1: interconnecting digital signals

Suppose you want to operate a drive via terminals DI 0 and DI 1 on the Control Unit using jog 1 and jog 2.

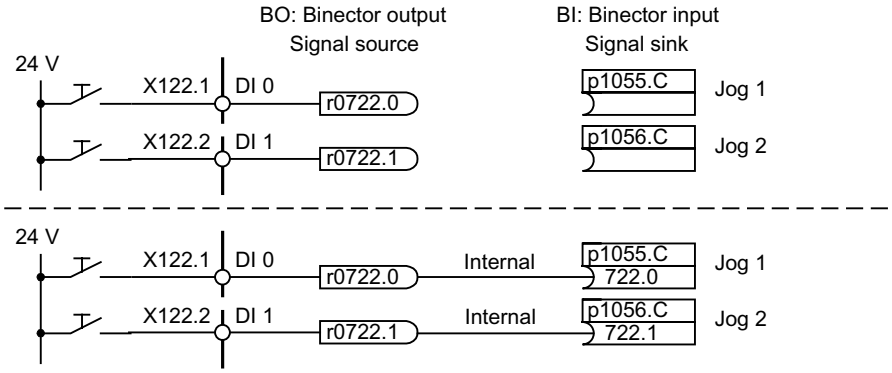


Figure 6-7 Interconnection of digital signals (example)

Example 2: connection of OC/OFF3 to several drives

The OFF3 signal is to be connected to two drives via terminal DI 2 on the Control Unit.

Each drive has a binector input 1. OFF3 and 2. OFF3. The two signals are processed via an AND gate to STW1.2 (OFF3).

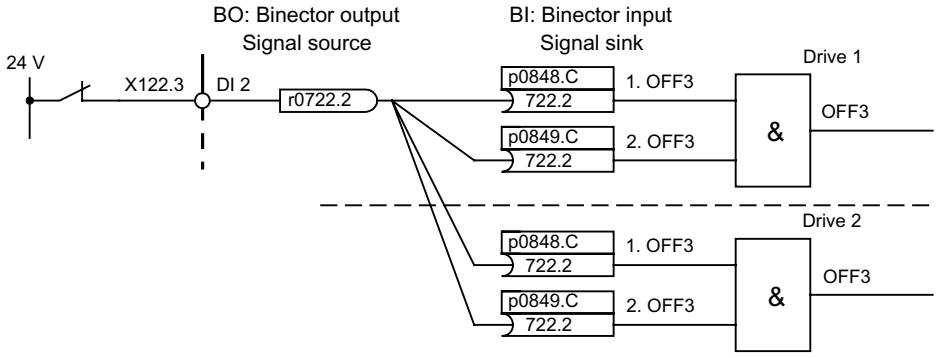


Figure 6-8 Connection of OFF3 to several drives (example)

BICO interconnections to other drives

The following parameters are available for BICO interconnections to other drives:

- r9490 Number of BICO interconnections to other drives
- r9491[0...15] BI/CI of BICO interconnections to other drives
- r9492[0...15] BO/CO of BICO interconnections to other drives
- p9493[0...15] Reset BICO interconnections to other drives

Binector-connector converters and connector-binector converters

Binector-connector converter

- Several digital signals are converted to a 32-bit integer double word or to a 16-bit integer word.
- p2080[0...15] BI: PROFIdrive PZD send bit-serial

Connector-binector converter

- A 32-bit integer double word or a 16-bit integer word is converted to individual digital signals.
- p2099[0...1] CI PROFIdrive PZD selection receive bit-serial

Fixed values for interconnection using BICO technology

The following connector outputs are available for interconnecting any fixed value settings:

- p2900[0...n] CO: Fixed value_%_1
- p2901[0...n] CO: Fixed value_%_2
- p2930[0...n] CO: Fixed Value_M_1

Example:

These parameters can be used to interconnect the scaling factor for the main setpoint or to interconnect an additional torque.

6.4 Command sources

6.4.1 "PROFIdrive" default setting

Prerequisites

- The Power Module and CU320 have been correctly installed.
- The "PROFIdrive" default setting was chosen during commissioning:

- STARTER: "PROFIdrive"
- AOP30: "1: G130 PROFIdrive"

Command sources

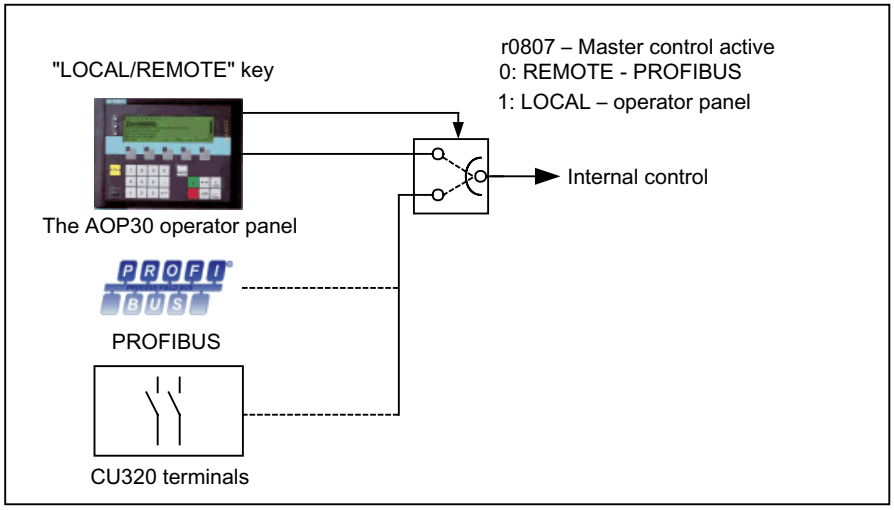


Figure 6-9 Command sources - AOP30 ←→ PROFIdrive

Priority

The command source priorities are shown in the diagram "Command sources - AOP30 ←→ PROFIdrive".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

CU320 terminal assignment with "PROFIdrive" default setting

When you choose the "PROFIdrive" default setting, the terminal assignment for CU320 is as follows:

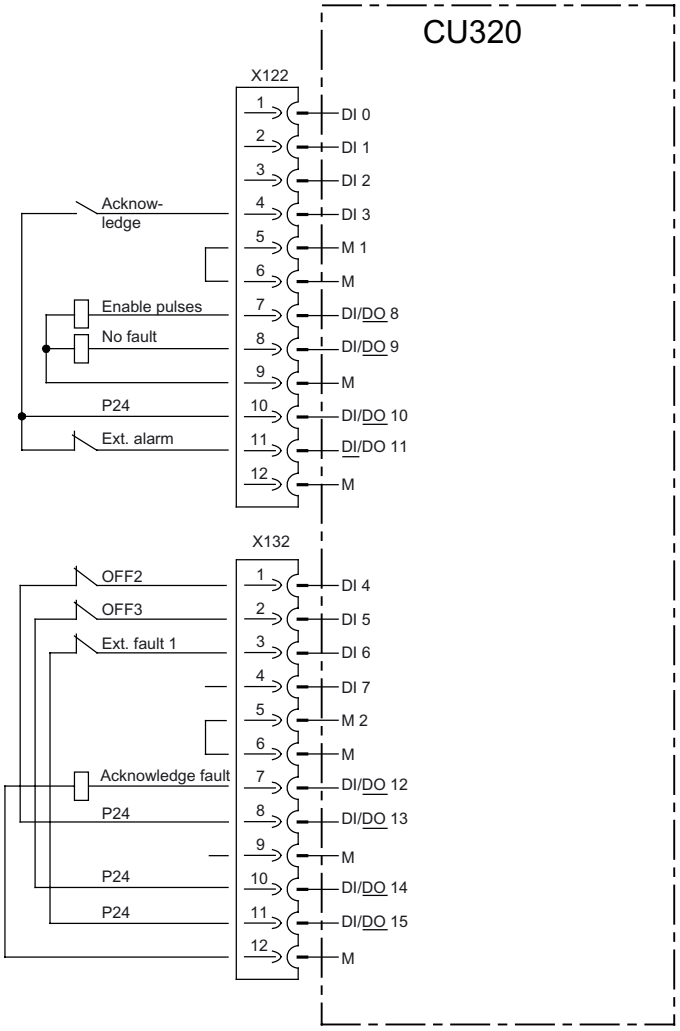


Figure 6-10 CU320 terminal assignment with "PROFIdrive" default setting

Control word 1

The bit assignment for control word 1 is described in "Description of the control words and setpoints".

Status word 1

The bit assignment for status word 1 is described in "Description of the status words and actual values".

Switching the command source

The command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.2 "TM31 terminals" default setting

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" default setting was chosen during commissioning:

- STARTER "TM31 terminals"
- AOP30: "2: TM31 terminals

Command sources

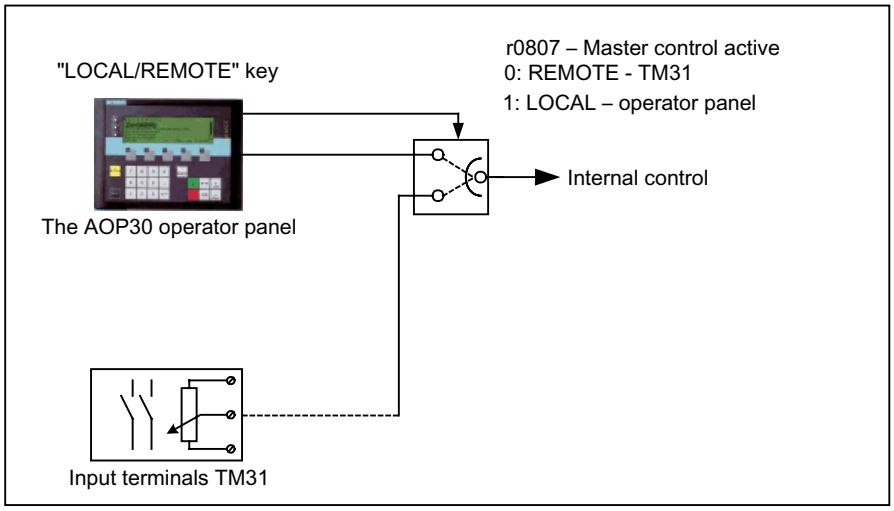


Figure 6-11 Command sources AOP30 ←→ terminal TM31

Priority

The command source priorities are shown in the diagram "Command sources AOP30 ←→ TM31 terminals".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

TM31 terminal assignment with "TM31 terminals" default setting

When you choose the "TM31 terminals" default setting, the terminal assignment for TM31 is as follows:

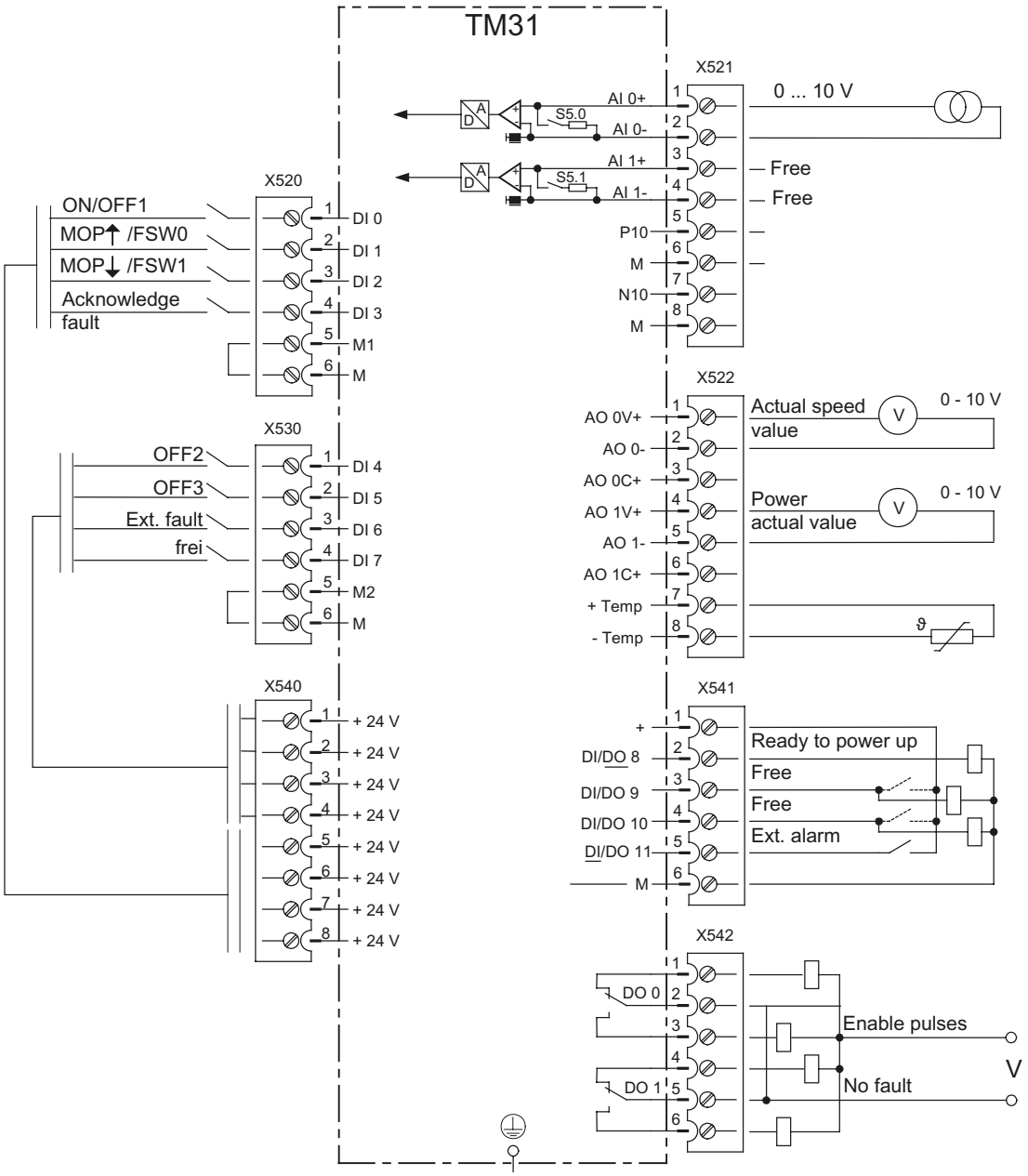


Figure 6-12 TM31 terminal assignment with "TM31 terminals" default setting

Switching the command source

If necessary, the command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.3 "CU terminals" default setting

Prerequisites

- The Power Module and CU320 have been correctly installed.
- The "CU terminals" default setting was chosen during commissioning:

- STARTER: "CU terminals"
- AOP30: "3: CU terminals"

Command sources

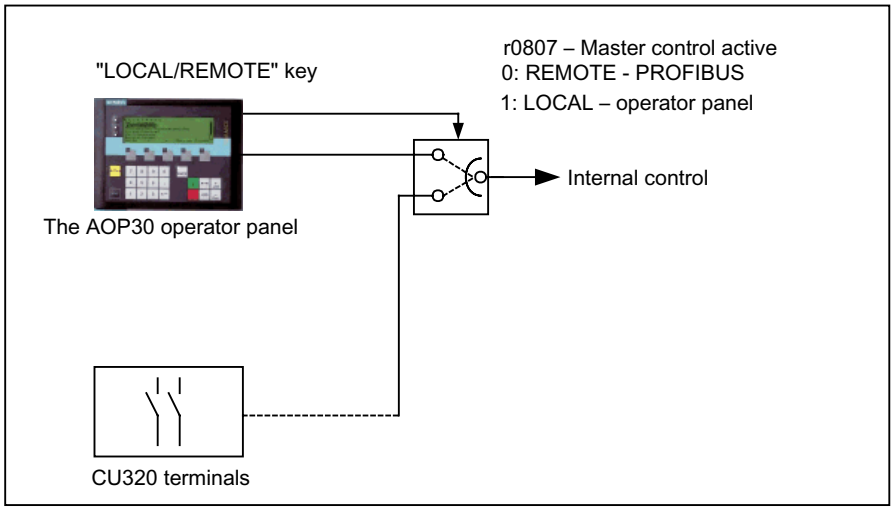


Figure 6-13 Command sources AOP30 ←→ CU terminal

Priority

The command source priorities are shown in the diagram "Command sources AOP30 ←→ CU terminals".

Note

For LOCAL master control, all of the supplementary setpoints are deactivated.

CU320 terminal assignment with "CU terminals" default setting

When you choose the "CU terminals" default setting, the terminal assignment for CU320 is as follows:

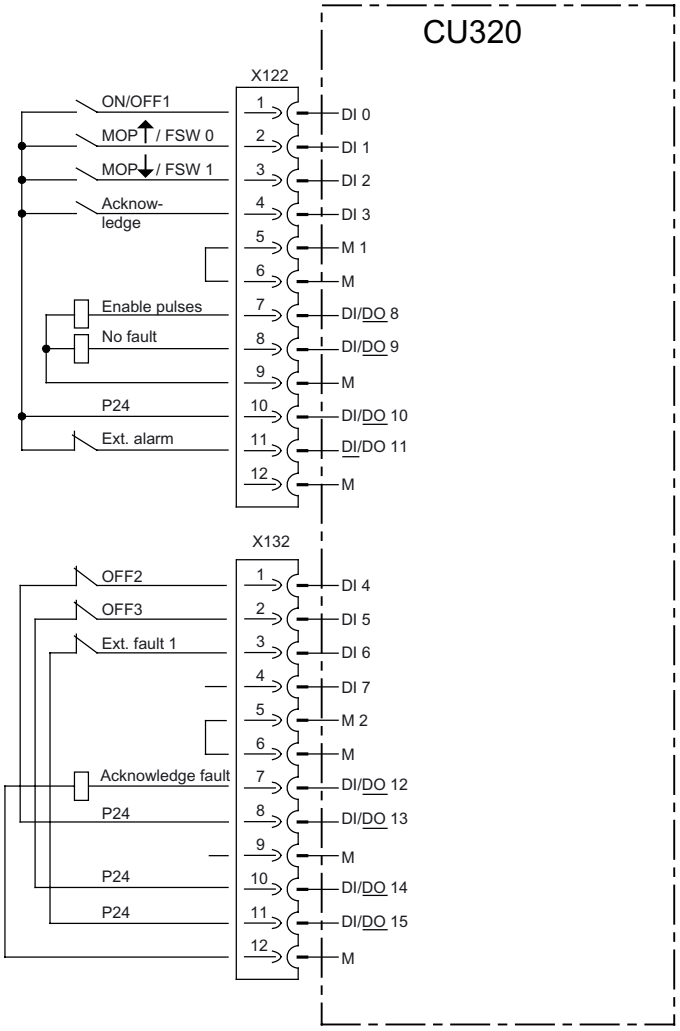


Figure 6-14 CU320 terminal assignment with "CU terminals" default setting

Switching the command source

If necessary, the command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.4.4 "PROFIdrive+TM31" default setting

Prerequisites

- The Power Module, CU320, TM31, and PROFIBUS have been correctly installed.
- The "PROFIdrive+TM31" default setting was chosen during commissioning:

STARTER: "PROFIdrive+TM31"
AOP30: "4: PROFIdrive+TM31"

Command sources

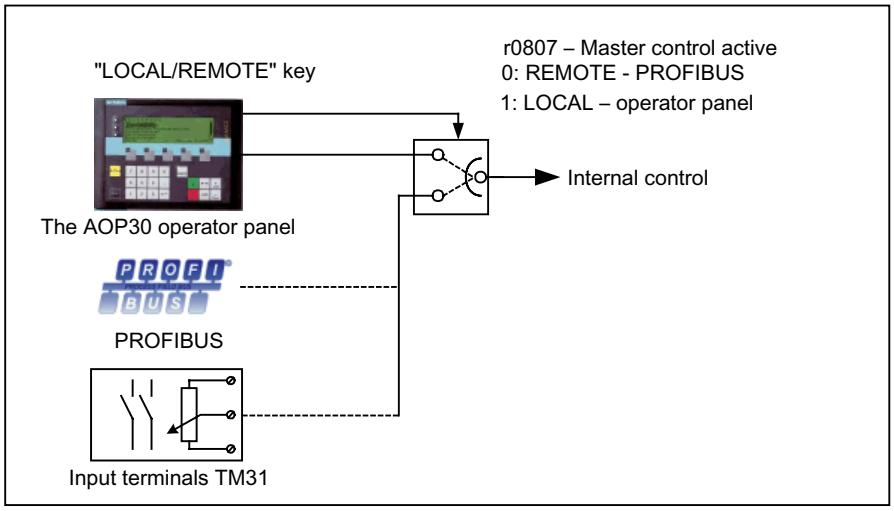


Figure 6-15 Command sources - AOP30 ←→ PROFIdrive+TM31

Priority

The command source priorities are shown in the diagram "Command sources - AOP30 ←→ PROFIdrive+TM31".

Note

All of the supplementary setpoints are deactivated for LOCAL master control.

TM31 terminal assignment with "PROFIdrive+TM31" default setting

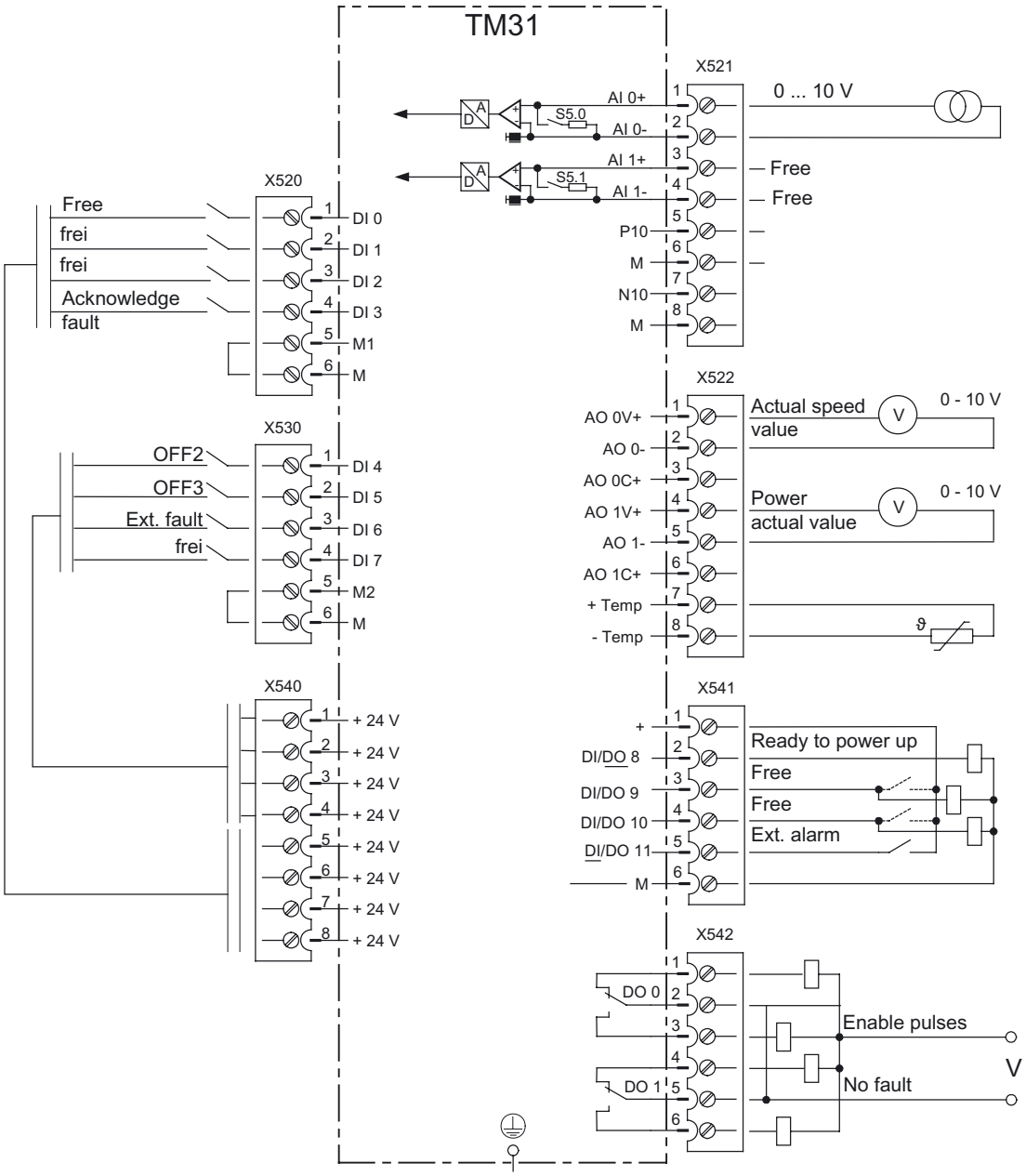


Figure 6-16 TM31 terminal assignment with "PROFIdrive+TM31" default setting

Switching the command source

If necessary, the command source can be switched using the LOCAL/REMOTE key on the AOP30.

6.5 Setpoint sources

6.5.1 Analog inputs

Description

The customer terminal block TM31 features two analog inputs for specifying setpoints for current or voltage signals.

In the factory setting, analog input 0 (terminal X521:1/2) is used as a voltage input in the range 0 ... 10 V.

Prerequisites

- The TM31 has been correctly installed.
- The default setting for analog inputs was chosen during commissioning:

  - STARTER: "TM31 terminals"
  - AOP30: "2: TM31 terminals

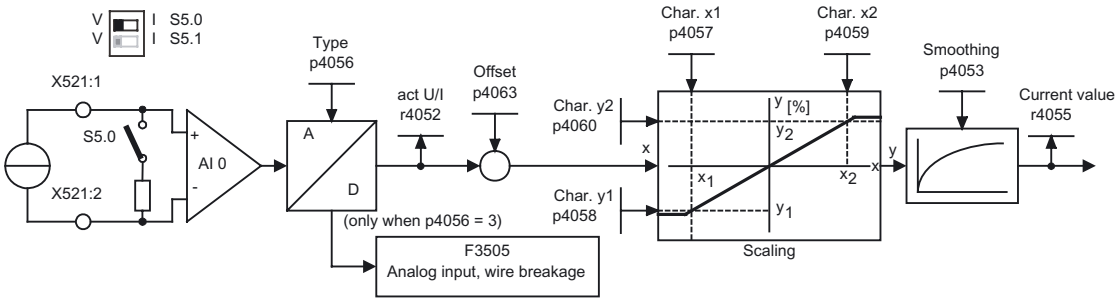


Figure 6-17 Signal flow diagram: analog input 0

Function diagram

FD 9566	TM31 – analog input 0 (AI 0)
FD 9568	TM31 – analog input 1 (AI 1)

Parameters

- r4052 Actual input voltage/current
- p4053 Analog inputs, smoothing time constant
- r4055 Analog inputs, actual value in percent
- p4056 Analog inputs, type
- p4057 Analog inputs, characteristic value x1
- p4058 Analog inputs, characteristic value y1
- p4059 Analog inputs, characteristic value x2

- p4060 Analog inputs, characteristic value y2
- p4063 Analog inputs offset

Note

In the factory setting and after basic commissioning, an input voltage of 10 V is equal to the main setpoint 100% reference speed (p2000), which has been set to the maximum speed (p1082).

Example: changing analog input 0 from voltage to current input 0 - 20 mA

Table 6-5 Example: setting analog input 0

S5.0 = "I"	**Curren/voltage switchover** Set current /voltage selector to "Current" ("I").
p4056[0] = 2	Set analog input type 0 to 0 ... 20 mA.

Note

The change to the analog input must then be stored on the CompactFlash card so that it is protected in the event of a power failure.

F3505 - Fault: "Analog input wire breakage"

This fault is triggered when the analog input type (p4056) is set to 3 (4 ... 20 mA with open-circuit monitoring) and the input current of 2 mA has been undershot.

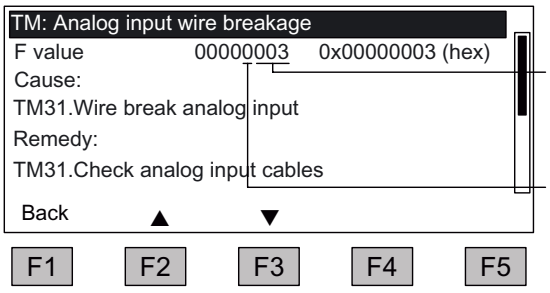
The fault value can be used to determine the analog input in question.

F3505 – Fault: "Analog input wire breakage"

This fault is triggered when the analog input type (p4056) is set to 3 (4 ... 20 mA with open-circuit monitoring) and the input current of 2 mA has been undershot.

The fault value can be used to determine the analog input in question.

Table 6-6 Fault screen



Component number
3: 1. TM31
4: 2. TM31

0: Analog input 0: -X521:1/2
1: Analog input 1: -X521:3/4

6.5.2 Motorized potentiometer

Description

The digital motorized potentiometer enables you to set speeds remotely using switching signals (+/- keys). It is activated via terminals or PROFIBUS. As long as a logical 1 is present at signal input "MOP raise" (setpoint higher), the internal numerator integrates the setpoint. You can set the integration time (time taken for the setpoint to increase) using parameter p1047. In the same way, you can decrease the setpoint using signal input "MOP lower". The deceleration ramp can be set using parameter p1048.
Configuration parameter p1030.0 = 1 (default setting = 0) is used to activate that the actual motorized potentiometer is saved in a non-volatile fashion when powering-down the drive unit. When powering-up the drive unit, the starting (initial) value of the motorized potentiometer is set to the last, actual value that was present when the drive unit was powered-down.

Prerequisites

The default setting for the motorized potentiometer was chosen during commissioning:

- STARTER: "Motorized potentiometer"
- AOP30: "3: Motorized potentiometer"

Signal flow diagram

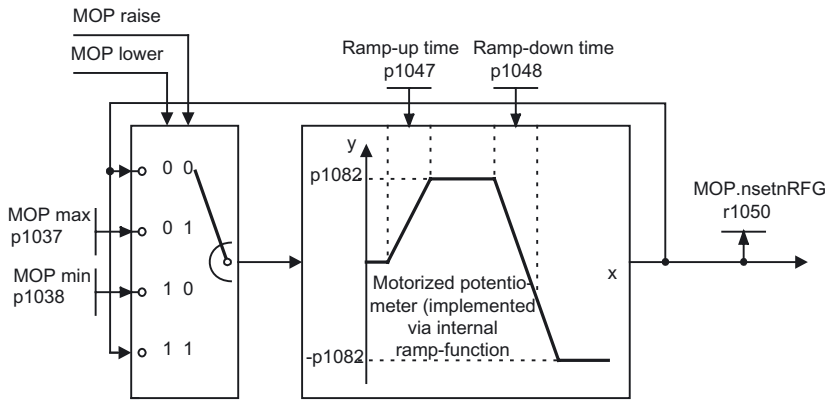


Figure 6-18 Signal flow diagram: Motorized potentiometer

Function diagram

FD 3020 Motorized potentiometer

Parameters

- p1030 Motorized potentiometer, configuration
- p1037 Motorized potentiometer, maximum speed
- p1038 Motorized potentiometer, minimum speed
- p1047 Motorized potentiometer, ramp-up time
- p1048 Motorized potentiometer, ramp-down time
- r1050 Motorized potentiometer, setpoint after the ramp-function generator

6.5.3 Fixed speed setpoints

Description

Three variable fixed speed setpoints are available. They can be selected via terminals or PROFIBUS.

Prerequisites

The default setting for the fixed speed setpoints was chosen during commissioning:

- STARTER: "Fixed setpoint"
- AOP30: "4: Fixed setpoint"

Signal flow diagram

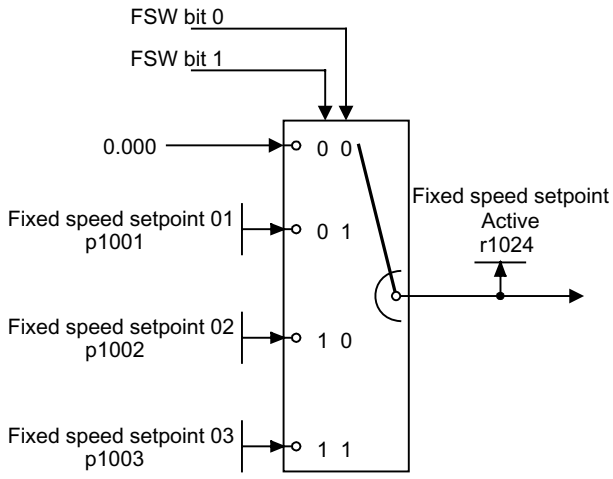


Figure 6-19 Signal flow diagram: Fixed speed setpoints

Function diagram

FD 3010	Fixed speed setpoints

Parameters

- p1001 Fixed speed setpoint 01
- p1002 Fixed speed setpoint 02
- p1003 Fixed speed setpoint 03
- r1024 Fixed speed setpoint effective

Note

Other fixed speed setpoints are available using p1004 to p1015. They can be selected using p1020 to p1023.

6.6 PROFIBUS

6.6.1 PROFIBUS connection

For more information about the PROFIBUS connection, see "Electrical installation".

6.6.2 Control via PROFIBUS

"DP1 (PROFIBUS)" diagnostics LED

The PROFIBUS diagnostics LED is located on the front of the Control Unit CU320. Its statuses are described in the following table.

Table 6-7 Description of the LEDs

Color	Status	Description
-----	Off	Cyclic communication has not (yet) taken place.
Green	Continuous	PROFIBUS is ready for communication and cyclic communication is taking place.
Green	0.5 Hz flashing light	Full cyclic communication is not yet taking place. Possible causes: The master is not transmitting setpoints.
Red	Continuous	Cyclic communication has been interrupted.

Setting the PROFIBUS ID number

The PROFIBUS Ident Number (PNO-ID) can be set using p2042.

SINAMICS can be operated on PROFIBUS with various identities, This allows a PROFIBUS GSD that is independent of the device to be used (e.g. PROFIdrive VIK-NAMUR with Ident Number 3AA0 hex).

- 0: SINAMICS S/G
- 1: VIK-NAMUR

A new setting only becomes effective after POWER ON, reset or download.

Note

The advantages of Totally Integrated Automation (TIA) can only be utilized when selecting "0".

6.6.3 Monitoring: Telegram failure

Description

Following a telegram failure and after a monitoring time has elapsed (t_An), bit r2043.0 is set to "1" and alarm A01920 is output. Binector output r2043.0 can be used for an emergency stop, for example.

Once a delay time (p2044) has elapsed, fault F01910 is output and fault reaction OFF3 (quick stop) is triggered. If no OFF response is to be triggered, the fault response can be reparameterized accordingly.

Fault F01910 can be acknowledged immediately. The drive can then be operated even without PROFIBUS.

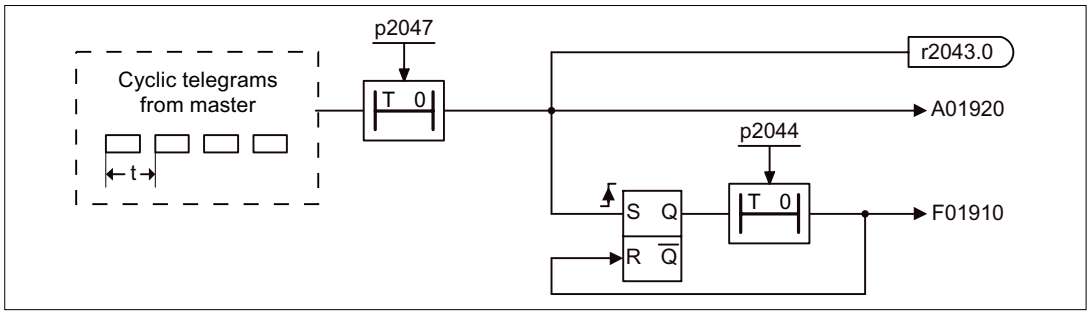


Figure 6-20 Monitoring: Telegram failure

6.6.4 Telegrams and process data

General information

Selecting a telegram via CU parameter p0922 determines which process data is transferred between the master and slave.

From the perspective of the slave (SINAMICS), the received process data comprises the receive words and the process data to be sent the send words.

The receive and send words comprise the following elements:

- Receive words: Control words and setpoints
- Send words: Status words and actual values

Default setting "Profidrive"

When the "Profidrive" default setting is chosen for command and setpoint selection (see "Command sources / "Profidrive" default settings"), "Free telegram" (p0922 = 999) is selected.

The receive message frame is parameterized as follows as a result of the default setting (plan 622):

STW 1	N_SETP

The send telegram is parameterized as follows (factory setting, plan 623):

ZSW 1	N_ACT	I_IST	M_ACT	P_ACT	Fault

You do not have to make any further settings in order to use these telegrams.

User-defined telegram selection

a. Standard telegrams

Standard telegrams are structured in accordance with PROFIdrive profile V3 or internal company specifications. The internal process data links are established automatically in accordance with the telegram number setting in CU parameter p0922.

The following standard telegrams can be set via parameter p0922:

- p0922 = 1 -> Speed control, 2 words
- p0922 = 2 -> Speed control, 4 words
- p0922 = 3 -> speed control, 1 position encoder
- p0922 = 4 -> speed control, 2 position encoders
- p0922 = 20 -> NAMUR telegram
- p0922 = 352 -> PCS7 telegram

Depending on the setting in p0922, the interface mode of the control and status word is automatically set:

- p0922 = 1, 352, 999:
  STW 1/ZSW 1: Interface Mode SINAMICS / MICROMASTER, p2038 = 0
- p0922 = 20:
  STW 1/ZSW 1: Interface Mode PROFIdrive VIK-NAMUR, p2038 = 2

b Free telegrams (p0922 = 999)

Send and receive telegrams can be configured as required by using BICO technology to interconnect the send and receive words. The default process data assigned under a) is retained during the switchover to p0922 = 999, although it can be changed or supplemented at any time.

To maintain compliance with the PROFIdrive profile, however, the following assignments should be retained:

- Interconnect PZD receive word 1 as control word 1 (CTW 1)
- Interconnect PZD send word 1 as status word 1 (STW 1)

For more information about possible interconnections, see function diagrams FP2460 and FP2470 and the simplified diagrams 620 to 622.

Structure of the telegrams

Table 6-8 Structure of the telegrams

Telegr.	PZD1	PZD2	PZD 3	PZD 4	PZD 5	PZD 6	PZD 7	PZD 8	PZD 9	PZD 10
1	STW 1	N_set_A								
	ZSW 1	N_act_A								
2	STW 1	N_set_B		CTW2						
	ZSW 1	N_act_B		STW2						
3	STW 1	N_set_B		CTW2	G1_CTW					
	ZSW 1	N_act_B		STW2	G1_STW	G1_XIST1		G1_XACT2		
4	STW 1	N_set_B		CTW2	G1_CTW					
	ZSW 1	N_act_B		STW2	G1_STW	Further assignment, see FP2420				
20	STW 1	N_set_A								
	ZSW 1	N_act_A	Ia_act_ SMOOTH	M_act_ SMOOTH	P_act_ SMOOTH	MELD_NAMUR				
352	STW 1	N_set_A	PCS_3	PCS7_4	PCS7_5	PCS7_6				
	ZSW 1	N_act_A	Ia_act_ SMOOTH	M_act_ SMOOTH	WARN_ CODE	FAULT_ CODE				
999	STW 1	Free	Free	Free	Free	Free	Free	Free	Free	Free
	ZSW 1	Free	Free	Free	Free	Free	Free	Free	Free	Free

6.6.5 Description of control words and setpoints

Overview

Table 6-9 Overview of control words and setpoints

Abbreviation	Description	Parameters	Function diagram
STW 1	Control word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)	See table "Control word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)"	FP2442
STW 1	Control word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)	See table: "Control word 1"	FP2441
STW 2	Control word 2 (interface mode SINAMICS / MICROMASTER, p2038 = 0)		FP2444
N_set_A	Speed setpoint A (16-bit)	p1070	FP3030
N_set_B	Speed setpoint B (32-bit)	p1155	FP3080
PCS7_x	PCS7-specific setpoints		

Control word 1 (STW 1) (interface mode SINAMICS / MICROMASTER, p2038 = 0)

Table 6-10 Control word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)

Bit	Meaning	Explanation	Betriebsbedingung	BICO
0	**0 = OFF1 (OFF1)**	0: Deceleration on the deceleration ramp (p1121), then pulse block, main contactor (if fitted) is opened.	1	BI: p0840
	1 = ON			
1	**0 = Coast to stop (OFF2)**	0: Pulse block, main contactor (if fitted) is opened	1	BI: p0844 BI: p0845
	1 = Do not coast to stop			
	Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845			
2	**0 = Emergency stop (OFF3)**	0: Deceleration on the rapid-stop ramp (p1135), then pulse block, main contactor (if fitted) is opened.	1	BI: p0848
	1 = No emergency stop			
	Note: Control signal OFF3 is generated by ANDing BI: p0848 and BI: p0849.			
3	0 = Disable operation **1 = Enable operation**	1: Enable inverter, pulse enable, ramp-up with active setpoint	1	BI: p0852
		0: Pulse inhibit. The motor coasts down. The "Ready To Run" status remains set.		
4	**0 = Set ramp generator to zero** 1 = Enable ramp-function generator	0: The ramp generator output is set to setpoint "0".	1	BI: p1140
5	**0 = Freeze ramp generator** 1 = Restart ramp generator	0: The current setpoint is frozen at the ramp generator output.	1	BI: p1141
6	**1 = Enable speed setpoint** 0 = Inhibit speed setpoint	1: The speed setpoint at the input of the ramp-function generator is enabled.	1	BI: p1142
		0: The speed setpoint at the input of the ramp-function generator is set to zero. The drive brakes in accordance with the ramp-down time set in p1121.		
7	**0 -> 1 = Acknowledge error**	A positive signal transition acknowledges all the current faults	–	BI: p2103
	Note: Acknowledgement is realized with a 0/1 edge via BI: p2103 or BI: p2104 or BI: p2105.			
8	Reserved		–	–
9	Reserved		–	–
10	**1 = Control via PLC**	1: PROFIBUS control words and setpoints are analyzed.	1	BI: p0854
		0: PROFIBUS control words and setpoints are not analyzed.		
	Note: This bit should not be set to "1" until the PROFIBUS slave has returned an appropriate status via STW1.9 = "1".			
11	**1 = Direction of rotation changeover**	1: CCW phase sequence	–	BI: p1113
		0: CW phase sequence		
12	Reserved		–	–

Bit	Meaning	Explanation	Betriebsbedingung	BICO
13	**1 = Increase motorized potentiometer**		–	BI: p1035
14	**1 = Decrease motorized potentiometer**		-	BI: p1036
	Note: If motorized potentiometer raise and lower are 0 or 1 simultaneously, the current setpoint is frozen.			
15	Reserved		–	–

Control word 1 (STW 1) (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)

Table 6-11 Control word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)

Bit	Meaning	Explanation	Betriebsbedingung	BICO
0	**0 = OFF1 (OFF1)**	0: Deceleration on the deceleration ramp (p1121), then pulse block, main contactor (if fitted) is opened.	1	BI: p0840
	1 = ON			
1	**0 = Coast to stop (OFF2)**	0: Pulse block, main contactor (if fitted) is opened	1	BI: p0844 BI: p0845
	1 = Do not coast to stop			
	Note: Control signal OFF2 is generated by ANDing BI: p0844 and BI: p0845			
2	**0 = Emergency stop (OFF3)**	0: Deceleration on the rapid-stop ramp (p1135), then pulse block, main contactor (if fitted) is opened.	1	BI: p0848
	1 = No emergency stop			
	Note: Control signal OFF3 is generated by ANDing BI: p0848 and BI: p0849.			
3	0 = Disable operation **1 = Enable operation**	1: Enable inverter, pulse enable, ramp-up with active setpoint	1	BI: p0852
		0: Pulse inhibit. The motor coasts down. The "Ready To Run" status remains set.		
4	**0 = Set ramp generator to zero** 1 = Enable ramp-function generator	0: The ramp generator output is set to setpoint "0".	1	BI: p1140
5	**0 = Freeze ramp generator** 1 = Restart ramp generator	0: The current setpoint is frozen at the ramp generator output.	1	BI: p1141
6	**1 = Enable speed setpoint** 0 = Inhibit speed setpoint	1: The speed setpoint at the input of the ramp-function generator is enabled.	1	BI: p1142
		0: The speed setpoint at the input of the ramp-function generator is set to zero. The drive brakes in accordance with the ramp-down time set in p1121.		
7	**0 -> 1 = Acknowledge error**	A positive signal transition acknowledges all the current faults	–	BI: p2103
	Note: Acknowledgement is realized with a 0/1 edge via BI: p2103 or BI: p2104 or BI: p2105.			
8	Reserved		–	–
9	Reserved		–	–

Bit	Meaning	Explanation	Betriebsbedingung	BICO
10	**1 = Control via PLC**	1: PROFIBUS control words and setpoints are analyzed.	1	BI: p0854
		0: PROFIBUS control words and setpoints are not analyzed.		
	Note: This bit should not be set to "1" until the PROFIBUS slave has returned an appropriate status via STW1.9 = "1".			
11	**1 = Direction of rotation changeover**	1: CCW phase sequence	–	BI: p1113
		0: CW phase sequence		
12	Reserved		–	–
13	Reserved		–	–
14	Reserved		–	–
15	1 = Data set 2 0 = Data set 1	1: Parameter data set changeover (DDS) data set 2 is active	–	BI: p0820
		0: Parameter data set changeover (DDS) data set 1 is active		

Speed setpoint (N_Set_A)

- Speed setpoint with 16-bit resolution incl. sign bit.
- Bit 15 determines the setpoint sign:
  - Bit = 0 -> positive setpoint
  - Bit = 1 -> negative setpoint
- The speed setpoint is normalized via parameter p2000.
  N_set_A = 4000 hex or 16384 dec = speed in p2000

Speed setpoint (N_Set_B)

- Speed setpoint with 32-bit resolution incl. sign bit.
- Bit 31 determines the setpoint sign:
  - Bit = 0 -> positive setpoint
  - Bit = 1 -> negative setpoint
- The speed setpoint is normalized via parameter p2000.
  N_set_B = 4000 0000 hex or 1073741824 dec = speed in p2000

PCS7-specific setpoints (PCS7 x)

Depending on the configuration, KP adaptation values for the speed controller and acceleration values or other setpoints, for example, are transferred here. Depending on their application, these variables are generally normalized via parameters p2000 to p2004.

6.6.6 Description of status words and actual values

Overview

Table 6-12 Overview of status words and actual values

Abbreviation	Description	Parameters	Function diagram
ZSW 1	Status word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)"	See table "Status word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)"	FP2452
ZSW 1	Status word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)	See table "Status word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)"	FP2451
N_act_A	Speed setpoint A (16 bit)	r0063[0]	FP4715
N_act_B	Speed setpoint B (32 bit)	r0063	FP4710
Ia_act	Actual value of current	r0068[0]	FP6714
M_act	Actual torque value	r0080[0]	FP6714
P_act	Actual power value	r0082[0]	FP6714
N_act_SMOOTH	Actual speed smoothed	r0063[1]	FP4715
Ia_act_SMOOTH	Current actual value, smoothed	r0068[1]	FP6714
M_act_SMOOTH	Torque actual value, smoothed	r0080[1]	FP6714
P_act_SMOOTH	Power actual value, smoothed	r0082[1]	FP6714
MELD_NAMUR	VIK-NAMUR message bit bar	r3113, see table "NAMUR message bit bar"	--
WARN_CODE	Alarm code	r2132	FP8065
ERROR_CODE	Error code	r2131	FP8060

Status word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)"

Table 6-13 Status word 1 (interface mode SINAMICS / MICROMASTER, p2038 = 0)"

Bit	Meaning	Explanation		BICO
0	Ready to power up	1	Ready to power up Power supply on, electronics initialized, line contactor released if necessary, pulses inhibited.	BO: r0899.0
		0	Not ready to power up	
1	Ready	1	Ready Voltage at Line Module (i.e. line contactor closed (if used)), field being built up.	BO: r0899.1
		0	Not ready Cause: No ON command has been issued.	
2	Operation enabled	1	Operation enabled Enable electronics and pulses, then ramp up to active setpoint.	BO: r0899.2
		0	Operation inhibited	
3	Fault active	1	Fault active The drive is faulty and is, therefore, out of service. The drive switches to Power-on inhibit once the fault has been acknowledged and the cause has been remedied. The active faults are stored in the fault buffer.	BO: r2139.3
		0	No fault present There is no active fault in the fault buffer.	
4	No OFF2 active / coasting active (OFF2)	1	No OFF2 active	BO: r0899.4
		0	Coasting active (OFF2) An OFF2 command is present.	
5	0 = Fast stop active (OFF3)	1	No OFF3 active	BO: r0899.5
		0	Coasting active (OFF3) An OFF3 command is present.	
6	Power-on disable	1	Power-on disable A restart is only possible through OFF1 followed by ON.	BO: r0899.6
		0	No power-up inhibit Power-up is possible.	
7	Alarm present	1	Alarm present The drive is operational again. No acknowledgement necessary. The active alarms are stored in the alarm buffer.	BO: r2139.7
		0	No alarm present No active alarm is present in the alarm buffer.	
8	Speed setpoint/actual value deviation within tolerance bandwidth	1	Setpoint/actual value monitoring within tolerance bandwidth Actual value within tolerance band; dynamic overshoot or shortfall permitted for t < tmax, tmax can be parameterized. See FP8010	BO: r2197.7
		0	Setpoint/actual value monitoring not within tolerance band	

Bit	Meaning	Explanation		BICO
9	Control requested for PLC "1" is always present	1	Control from the PLC	BO: r0899.9
		0	Local operation	
10	f or n comparison value reached or exceeded	1	f or n comparison value reached or exceeded	BO: r2199.1
		0	f or n comparison value not reached	
	Note: The message is parameterized as follows: p2141 Threshold value p2142 Hysteresis			
11	I, M or P limit not reached / I, M or P limit reached	1	I, M or P limit not reached	BO: r1407.7
		0	I, M or P limit reached	
12	Reserved			
13	Alarm, motor overtemperature	1	Motor overtemperature alarm active	BO: r2135.14
		0	Motor overtemperature alarm not active	
14	Motor rotates forwards (n_act >= 0)	1	Motor rotates forward (n_act ≥ 0)	BO: r2197.3
		0	Motor does not rotate forward (n_act < 0)	
15	Alarm, drive converter thermal overload	1	No alarm present	BO: r2135.15
		0	Alarm, drive converter thermal overload The overtemperature alarm for the converter is active.	

Status word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)

Table 6-14 Status word 1 (interface mode PROFIdrive VIK-NAMUR, p2038 = 2)

Bit	Meaning	Explanation		BICO
0	Ready to power up	1	Ready to power up Power supply on, electronics initialized, line contactor released if necessary, pulses inhibited.	BO: r0899.0
		0	Not ready to power up	
1	Ready	1	Ready Voltage at Line Module (i.e. line contactor closed (if used)), field being built up.	BO: r0899.1
		0	Not ready Cause: No ON command has been issued.	
2	Operation enabled	1	Operation enabled Enable electronics and pulses, then ramp up to active setpoint.	BO: r0899.2
		0	Operation inhibited	
3	Fault active	1	Fault active The drive is faulty and is, therefore, out of service. The drive switches to Power-on inhibit once the fault has been acknowledged and the cause has been remedied. The active faults are stored in the fault buffer.	BO: r2139.3

Bit	Meaning	Explanation		BICO
		0	No fault present There is no active fault in the fault buffer.	
4	No OFF2 active / coasting active (OFF2)	1	No OFF2 active	BO: r0899.4
		0	Coasting active (OFF2) An OFF2 command is present.	
5	0 = Fast stop active (OFF3)	1	No OFF3 active	BO: r0899.5
		0	Coasting active (OFF3) An OFF3 command is present.	
6	Power-on disable	1	Power-on disable A restart is only possible through OFF1 followed by ON.	BO: r0899.6
		0	No power-up inhibit Power-up is possible.	
7	Alarm present	1	Alarm present The drive is operational again. No acknowledgement necessary. The active alarms are stored in the alarm buffer.	BO: r2139.7
		0	No alarm present No active alarm is present in the alarm buffer.	
8	Speed setpoint/actual value deviation within tolerance bandwidth	1	Setpoint/actual value monitoring within tolerance bandwidth Actual value within tolerance band; dynamic overshoot or shortfall permitted for t < tmax, tmax can be parameterized. See FP8010	BO: r2197.7
		0	Setpoint/actual value monitoring not within tolerance band	
9	Control requested for PLC "1" is always present	1	Control from the PLC	BO: r0899.9
		0	Local operation	
10	f or n comparison value reached or exceeded	1	f or n comparison value reached or exceeded	BO: r2199.1
		0	f or n comparison value not reached	
	Note: The message is parameterized as follows: p2141 Threshold value p2142 Hysteresis			
11	I, M or P limit not reached / I, M or P limit reached	1	I, M or P limit not reached	BO: r1407.7
		0	I, M or P limit reached	
12	Reserved			
13	Alarm, motor overtemperature	1	Motor overtemperature alarm active	BO: r2135.14
		0	Motor overtemperature alarm not active	
14	Motor rotates forwards (n_act >= 0)	1	Motor rotates forward (n_act ≥ 0)	BO: r2197.3
		0	Motor does not rotate forward (n_act < 0)	
15	Reserved			

NAMUR signaling bit bar

Table 6-15 NAMUR signaling bit bar

Bit	Meaning	0 signal	1 signal
00	Fault, drive converter data electronics / SW error	No	Yes
01	Line supply fault	No	Yes
02	DC link overvoltage	No	Yes
03	Fault, drive converter power electronics	No	Yes
04	Overtemperature, drive converter	No	Yes
05	Ground fault	No	Yes
06	Motor overload	No	Yes
07	Bus error	No	Yes
08	External safety trip	No	Yes
09	Fault, motor encoder	No	Yes
10	Error, internal communications	No	Yes
11	Fault, infeed	No	Yes
15	Other faults/errors	No	Yes

Actual speed value (N_Act_A, N_Act_SMOOTH)

- Actual speed value with 16-bit resolution incl. sign bit.
- Bit 15 determines the actual value sign:
  - Bit = 0 -> positive actual value
  - Bit = 1 -> negative actual value
- The actual speed value is normalized via parameter p2000.
  N_act_A = 4000 hex or 16384 dec = speed in p2000

Actual speed (N_act_B)

- Actual speed value with 32-bit resolution incl. sign bit.
- Bit 31 determines the actual value sign:
  - Bit = 0 -> positive actual value
  - Bit = 1 -> negative actual value
- The actual speed value is normalized via parameter p2000.
  N_act_B = 4000 0000 hex or 1073741824 dec = speed in p2000

Actual current value (Ia_Act, Ia_Act_SMOOTH)

- Actual current value with 16-bit resolution
- The actual current value is normalized via parameter p2002.
  Ia_act = 4000 hex or 16384 dec = current in p2002

Actual torque value (M_Act, M_Act_SMOOTH)

- Actual torque value with 16-bit resolution incl. sign bit.
- Bit 15 determines the actual value sign:
  - Bit = 0 -> positive actual value
  - Bit = 1 -> negative actual value
- The actual torque value is normalized via parameter p2003.
  M_act = 4000 hex or 16384 dec = torque in p2003

Actual power value (P_Act, P_Act_SMOOTH)

- Actual power value with 16-bit resolution incl. sign bit.
- Bit 15 determines the actual value sign:
  - Bit = 0 -> positive actual value
  - Bit = 1 -> negative actual value
- The actual power value is normalized via parameter p2004.
  P_act = 4000 hex or 16384 dec = power in p2004

Alarm code (WARN_CODE)

The number of the current alarm and the last alarm to occur are output here. Decimal notation is used (i.e. value 7910 dec = A07910 (motor overtemperature)).

Fault code (FAULT_CODE)

The number of the oldest fault still active is output here. Decimal notation is used (i.e. value 7860 dec = F07860 (external fault 1)).

6.7 PROFINET IO

6.7.1 Communication Board Ethernet CBE20

Description

Interface module CBE20 is used for communication via PROFINET.

The module must be installed line-side in the option slot of the CU320 Control Unit.

4 Ethernet interfaces are available on the module. Diagnosis of the function mode and communication are possible via LEDs.

Interface overview

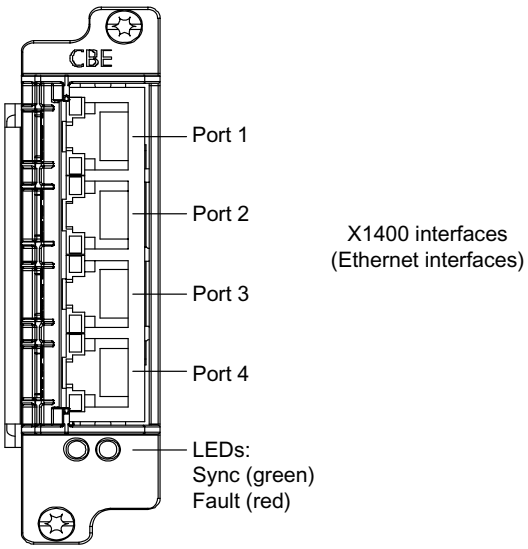


Figure 6-21 Communication Board Ethernet CBE20

MAC address

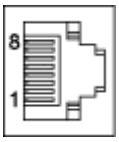
The MAC address of the Ethernet interfaces is indicated on the upper side of the CBE20. The label is only visible when the module has not yet been installed.

Note

Please note the MAC address prior to installing the module so that it is available to you for the subsequent commissioning.

X1400 Ethernet interface

Table 6-16 Connector X1400, port 1 - 4

	Pin	Signal name	Technical specifications
	1	RX+	Receive data +
	2	RX-	Receive data -
	3	TX+	Transmit data +
	4	---	Reserved, do not use
	5	---	Reserved, do not use
	6	TX-	Transmit data -
	7	---	Reserved, do not use
	8	---	Reserved, do not use
	Screened backshell	M_EXT	Screen, permanently connected

Mounting

CAUTION
The Option Board may only be inserted and removed when the Control Unit and Option Board are disconnected from the power supply.

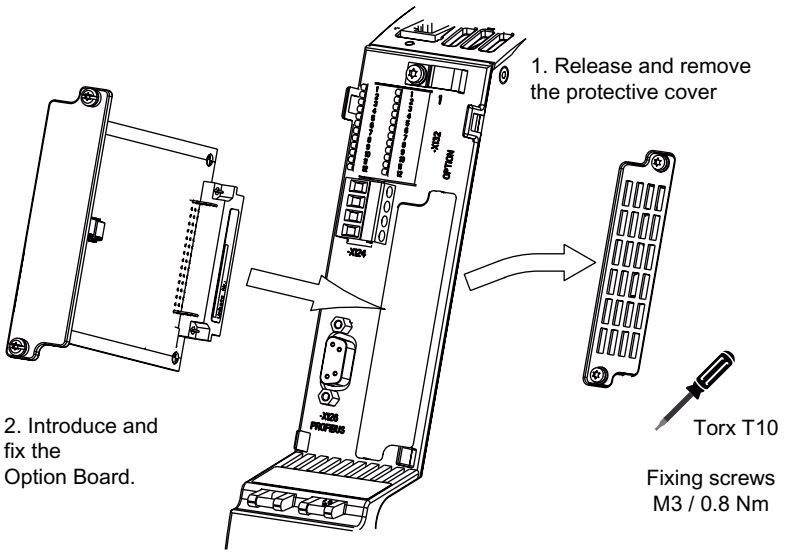


Figure 6-22 Mounting the CBE20

6.7.2 Activating online operation: STARTER via PROFINET IO

Description

The following options are available for online operation via PROFINET IO:

- Online operation via IP

Prerequisites

- STARTER with version ≥ 4.1.1
- Firmware version ≥ 2.5.1
- CBE20

STARTER via PROFINET IO (example)

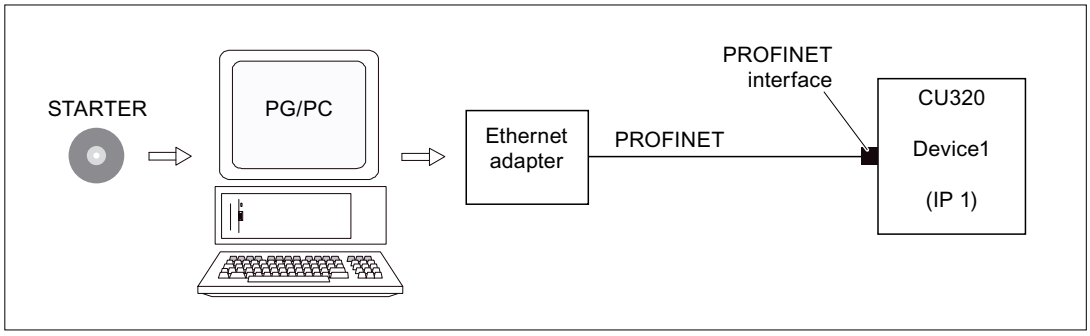


Figure 6-23 STARTER via PROFINET (example)

Procedure, establishing online operation with PROFINET

1. Set the IP address in Windows XP

   The PC/PG is referred here to a fixed, free IP address.
2. Settings in STARTER
3. Assignment of the IP address and the name for the PROFINET interface of the drive unit

   The PROFINET interface must be "baptized" so that the STARTER can establish communication.
4. Select online operation in STARTER.

Set the IP address in Windows XP

On the desktop, right-click on "Network environment" -> Properties -> double-click on Network card and choose -> Properties -> Internet Protocol (TCP/IP) -> Properties -> Enter the freely-assignable addresses.

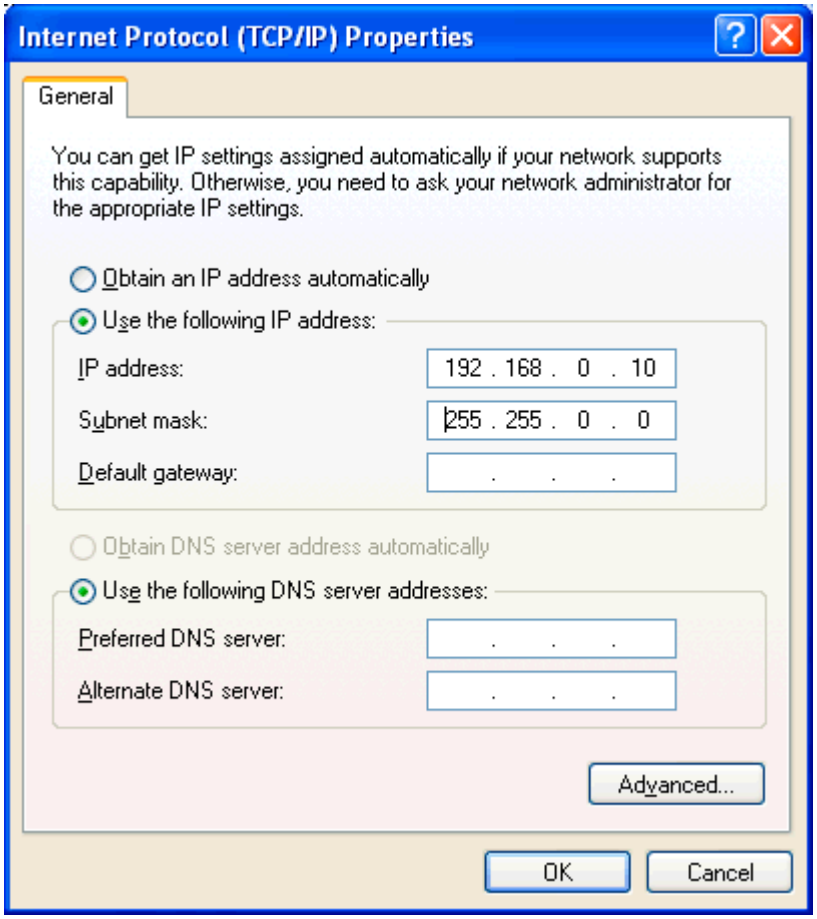

Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 0 . 10
Subnet mask:
255 . 255 . 0 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Figure 6-24 Properties of the Internet Protocol (TCP/IP)

Settings in STARTER

The following settings are required in STARTER for communication via PROFINET:

- Extras -> Set PG/PC interface

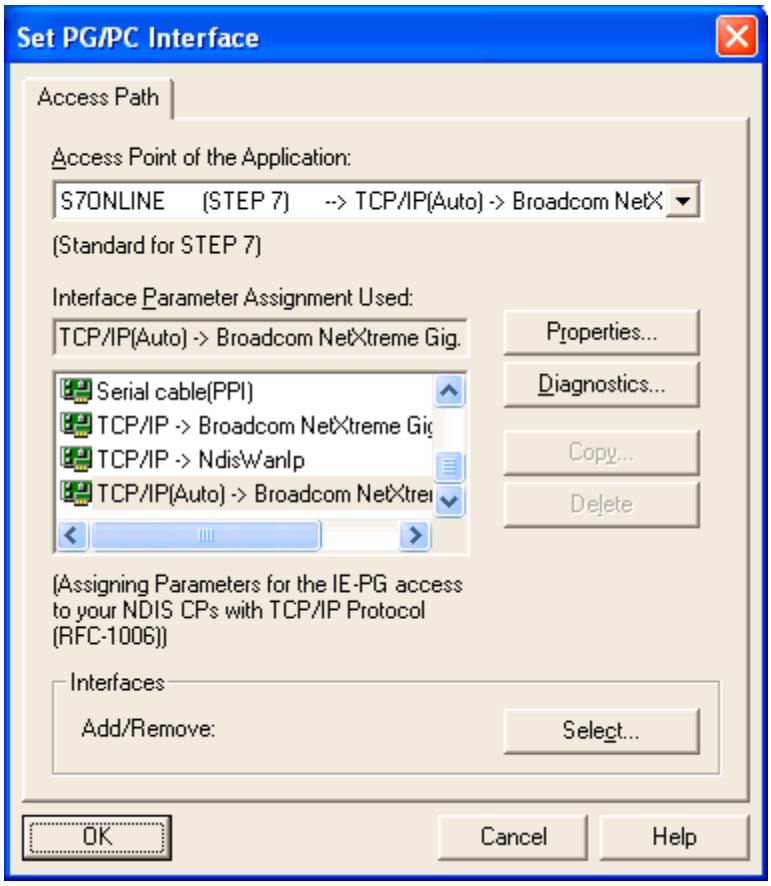


Figure 6-25 Set the PG/PC interface

Assignment of the IP address and the name for the PROFINET interface of the drive unit

Use the STARTER to assign an IP address and a name to the PROFINET interface (e.g. CBE20).

Requirement:

- Connect the direct Ethernet cable from the PG/PC to the PROFINET interface of the CU320 Control Unit.
- Switch on Control Unit CU320

The accessible nodes must be searched in the STARTER:

- Project -> Accessible nodes

Subsequently the nodes found are displayed in the interactive screen.

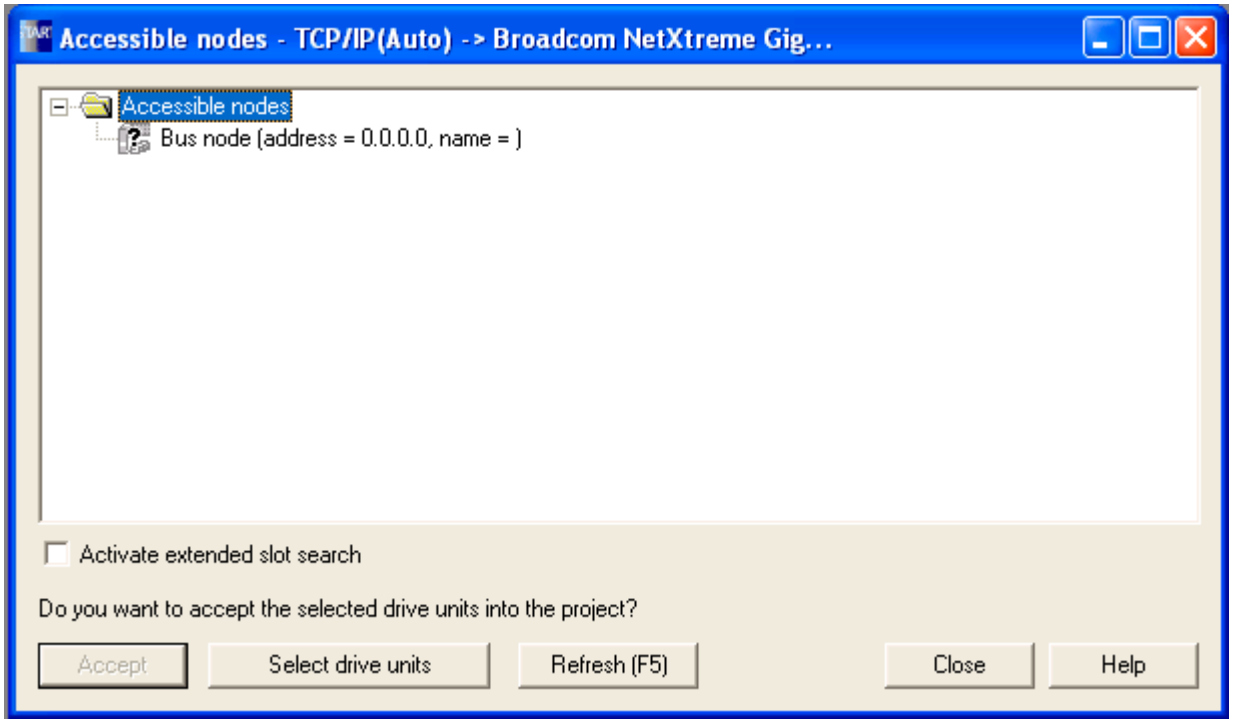

Accessible nodes - TCP/IP(Auto) -> Broadcom NetXtreme Gig...
Accessible nodes
Bus node (address = 0.0.0.0, name =)
Activate extended slot search
Do you want to accept the selected drive units into the project?
Accept
Select drive units
Refresh (F5)
Close
Help

Figure 6-26 STARTER -> Accessible nodes

The selected node is edited by selecting the field for the node with the right mouse button and selecting the option "Edit Ethernet node...".

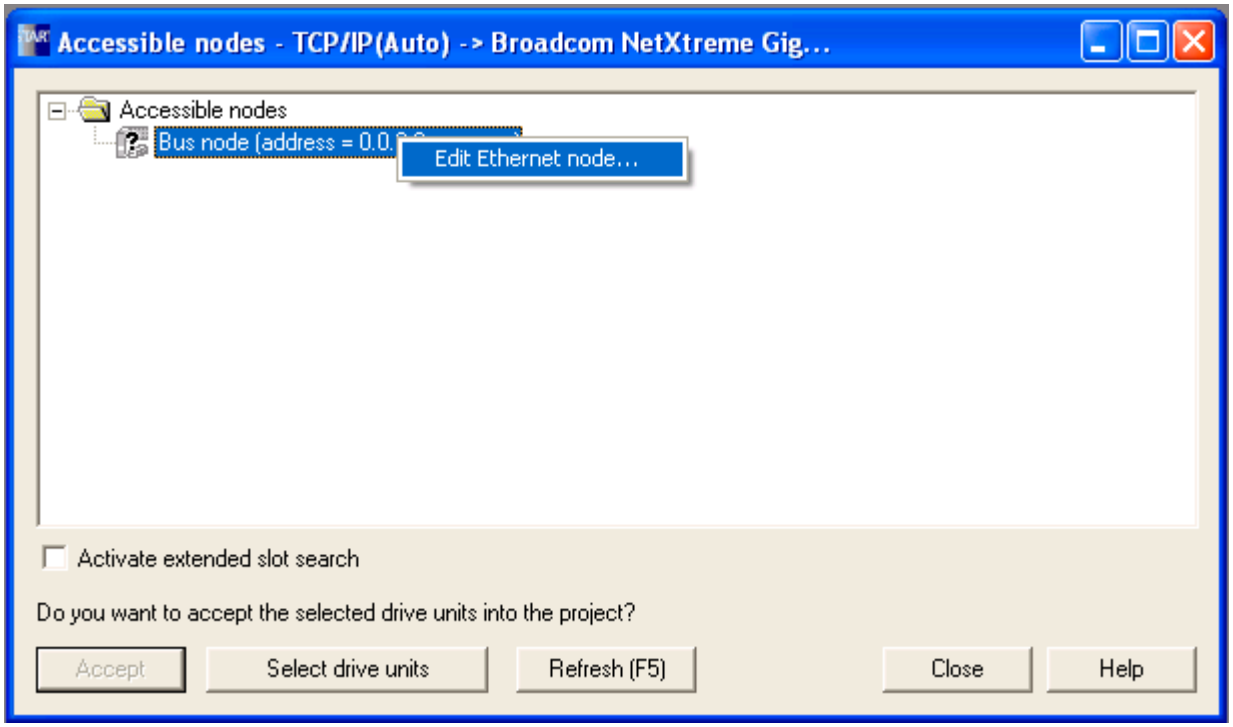


Figure 6-27 STARTER - Accessible nodes - Edit Ethernet node

In the following interactive screen enter a freely selectable device name and the IP address and subnet mask.

The subnet screens must match before STARTER can be run.

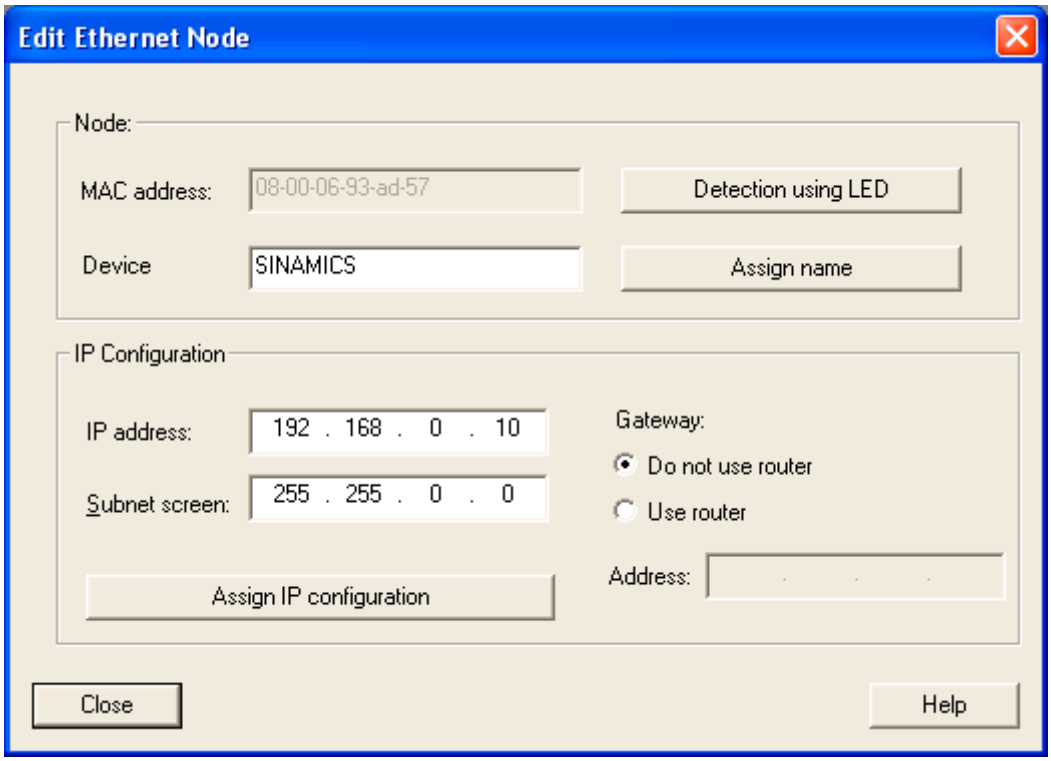


Figure 6-28 STARTER - Edit Ethernet nodes

After selecting the "Assign name" button, the following confirmation will appear if the assignment was successful.

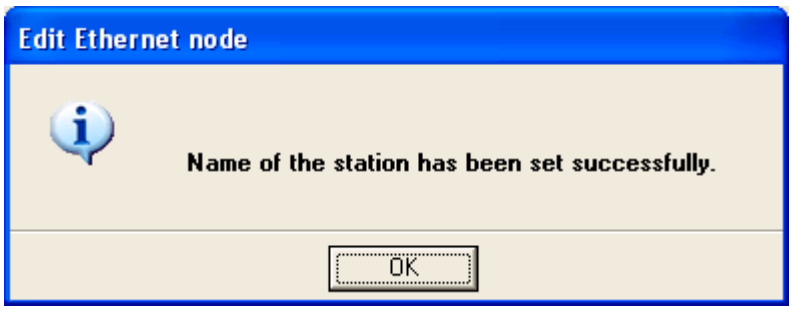


Figure 6-29 STARTER - Successful assignment of the device name

After selecting the "Assign IP configuration" button, the following confirmation will appear if the assignment was successful.

Figure 6-30 STARTER - Successful assignment of the IP configuration

After closing the "Edit Ethernet node" interactive screen the successful "christening" of the node is displayed in the node overview after updating (F5).

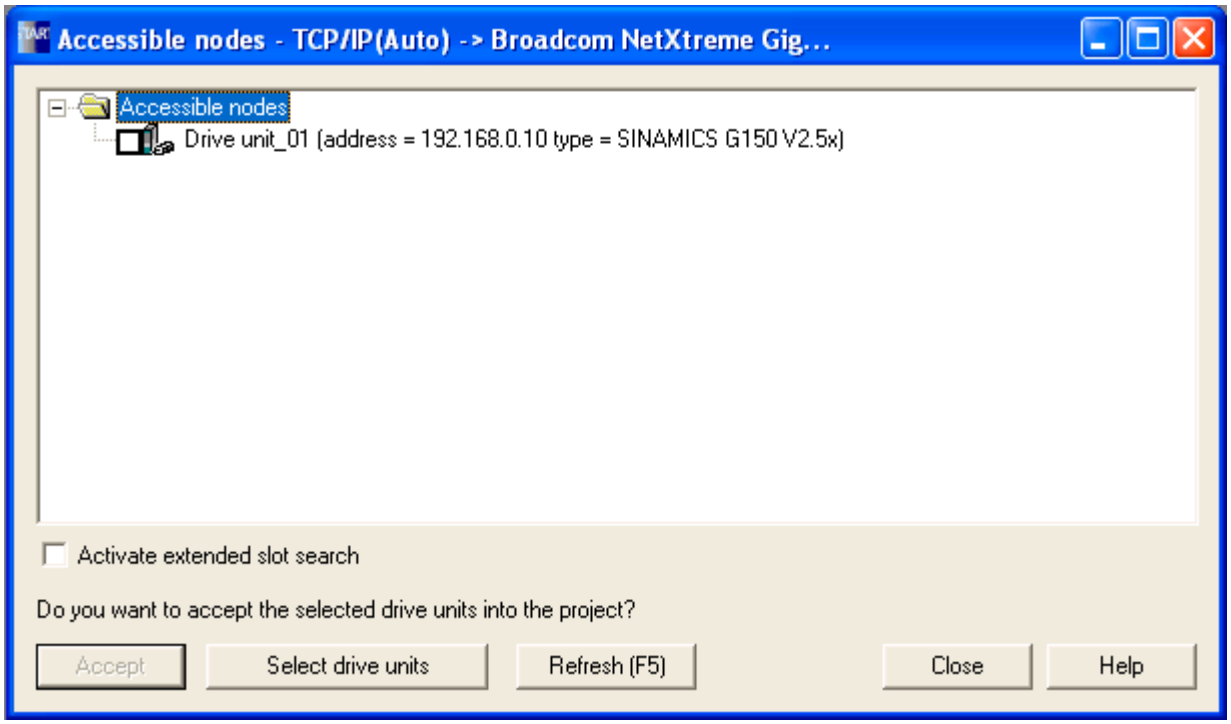

Accessible nodes - TCP/IP(Auto) -> Broadcom NetXtreme Gig...
Accessible nodes
Drive unit_01 (address = 192.168.0.10 type = SINAMICS G150 V2.5x)
Activate extended slot search
Do you want to accept the selected drive units into the project?
Accept
Select drive units
Refresh (F5)
Close
Help

Figure 6-31 STARTER - Accessible nodes update completed

Note

The IP address and device name for the Control Unit are stored on the CompactFlash Card (non-volatile).

6.7.3 General information about PROFINET IO

6.7.3.1 General information about PROFINET IO for SINAMICS

General information

PROFINET IO is an open Industrial Ethernet standard for a wide range of production and process automation applications. PROFINET IO is based on Industrial Ethernet and observes TCP/IP and IT standards.

The following standards ensure open, multi-vendor systems:

- International standard IEC 61158

PROFINET IO is optimized for high-speed, time-critical data communication at field level.

PROFINET

Within the framework of Totally Integrated Automation (TIA), PROFINET represents a consequent enhancement of:

- PROFIBUS DP, the established field bus,
  and
- Industrial Ethernet, the communications bus for the cell level.

Experience gained from both systems was and is being integrated into PROFINET. As an Ethernet-based automation standard defined by PROFIBUS International (PROFIBUS user organization), PROFINET is a manufacturer-independent communication and engineering model.

When a CBE20 Communication Board is inserted, SINAMICS G130 becomes an IO device in terms of PROFINET. With SINAMICS G130 and CBE20 can be used for communication via PROFINET IO with RT.

Note

PROFINET for drive technology is standardized and described in the following document:

References:
PROFIdrive Profile Drive Technology
PROFINET System Description,
Order no. 6ES7398-8FA10-8AA0, 6ES7151-1AA10-8AA0

6.7.3.2 Real-time (RT) and isochronous real-time (IRT) communication

Real-time communication

If supervisors are involved in communication, this can result in excessively long runtimes for the production automation system. When communicating time-critical IO user data, PROFINET therefore uses its own real time channel, rather than TCP/IP.

Definition: Real Time (RT) and determinism

Real time means that a system processes external events over a defined period.

Determinism means that a system responds in a predictable manner (deterministically).

In industrial networks, both of these requirements are important. PROFINET meets these requirements. PROFINET is implemented as a deterministic real time network as follows:

- Transmission of time-critical data takes place at guaranteed time intervals. To achieve this, PROFINET provides an optimized communication channel for real time communication: Real Time (RT).
- An exact prediction of the time at which the data transfer takes place is possible.
- Problem-free communication using other standard protocols is guaranteed within the same network.

Definition: Isochronous real time communication (IRT)

Isochronous Real Time Ethernet: Real time properties of PROFINET IO where IRT telegrams are transmitted deterministically via planned communication paths in a defined sequence to achieve the best possible synchronism and performance. This is also known as time-scheduled communications whereby knowledge about the network structure is utilized. IRT requires special network components that support planned data transfer.

When the transfer procedure is implemented in the ERTEC ASICs (Enhanced Real-Time Ethernet Controller), this results in cycle times of at least. 500 µs and a jitter accuracy of less than 1 µs.

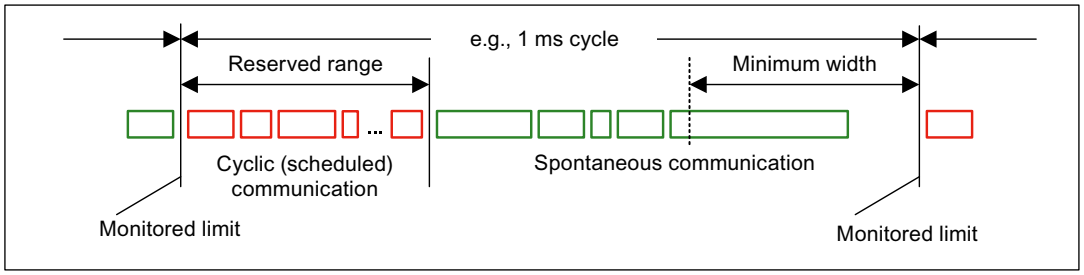


Figure 6-32 Broadband distribution/reservation, PROFINET IO IRT

Note

When operating S7-300 stations with SINAMICS drives, presently only communications via PROFINET IO with RT are possible.

6.7.3.3 Addresses

Definition: MAC address

Each PROFINET device is assigned a worldwide unique device identifier in the factory. This 6-byte long device identifier is the MAC address. The MAC address is divided up as follows:

- 3 bytes manufacturer's ID and
- 3 bytes device identifier (consecutive number).

The MAC address is usually indicated on the front of the device.

e.g.: 08-00-06-6B-80-C0

IP address

To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device also requires an IP address that is unique within the network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by a period. The IP address is made up of

- The address of the (sub-) network and
- The address of the node (generally called the host or network node)

IP address assignment

The TCP/IP protocol is a prerequisite for establishing a connection and parameterization. This is the reason that an IP address is required.

The IP addresses of IO devices can be assigned by the IO controller and always have the same sub-network mask as the IO controller. The can be consecutively assigned from the IP address of the IO controller. The IP address can be changed manually, if necessary - and is saved in a volatile fashion.

If the IP address is to be stored in a non-volatile memory, the address must be assigned using the Primary Setup Tool (PST).

This can also be carried out in HWConfig in STEP 7, where the function is called "Edit Ethernet node".

Note

If the network is part of an existing Ethernet company network, obtain the information from your network administrator (IP address, sub-network mask and a router that is possibly being used.)

Device name

When it is shipped, an IO device does not have a device name. An IO device can only be addressed by an IO controller, for example, for the transfer of project engineering data (including the IP address) during startup or for user data exchange in cyclic operation, after it has been assigned a device name with the IO supervisor.

Replacing Control Unit CU320 (IO Device)

If the IP address and device name are stored in a non-volatile memory, this data is also forwarded with the memory card (CF card) of the Control Unit.

If an IO device must be completely replaced due to a device or module defect, the Control Unit automatically assigns parameters and configures the new device or module. Following this, cyclic exchange of user data is restarted. The CF card allows module exchange without an IO supervisor when a fault occurs in a PROFINET device.

Definition: Sub-network mask

The bits set in the sub-network define the part of the IP address that contains the address of the (sub-) network. The following generally applies:

- The network address is obtained by an AND operation on the IP address and sub-network mask
- The node address is obtained by an AND NOT operation on the IP address and sub-network mask.

Example of the sub-network mask

Sub-network mask: 255.255.0.0 (decimal) = 11111111.11111111.00000000.00000000 (binary) IP address: 140.80.0.2 significance: The first 2 bytes of the IP address decide the sub-network - in other words 140.80. The last two bytes address the node - in other words 0.2.

Default router

If data needs to be forwarded by means of TCP/IP to a partner located outside the sub-network, this is carried out via the default router. In the properties dialog in STEP 7 (Properties of Ethernet interface > Parameters > Network transfer), the default router is described as the router. STEP 7 assigns the local IP address to the default router.

6.7.3.4 Data transmission

Features

The Communication Board CBE20 supports:

- IRT – isochronous real-time Ethernet
- RT – real-time Ethernet
- Standard Ethernet services (TCP/IP, LLDP, UDP and DCP)

PROFIdrive telegram for cyclic data transmission and non-cyclic services

Telegrams to send and receive process data are available for each drive object of a drive unit with cyclic process data exchange. In addition to cyclic data transfer, acyclic services can also be used for parameterizing and configuring the drive. These acyclic services can be used by the supervisor or the controller.

The total length of the Ethernet frame increases with the number of drive objects in a drive unit.

Sequence of drive objects in the data transfer

The sequence of drive objects is displayed via a list in p0978[0...15] where it can also be changed.

Note

The sequence of drive objects in HW Config must be the same as that in the drive (p0978).

NOTICE
A ring-type topology is not permissible.

6.7.4 Hardware setup

6.7.4.1 Configuring SINAMICS drives with PROFINET

Communication Board Ethernet CBE20

The CBE20 option board is inserted in the option slot of the CU320. The CBE20 is equipped with four ports that can be used to connect the PROFINET sub-network.

Step 7 routing with CBE20

The CBE20 does not support STEP 7 routing between PROFIBUS and PROFINET IO.

Connecting the supervisor

You can go online with the STARTER in a number of ways, which are illustrated below:

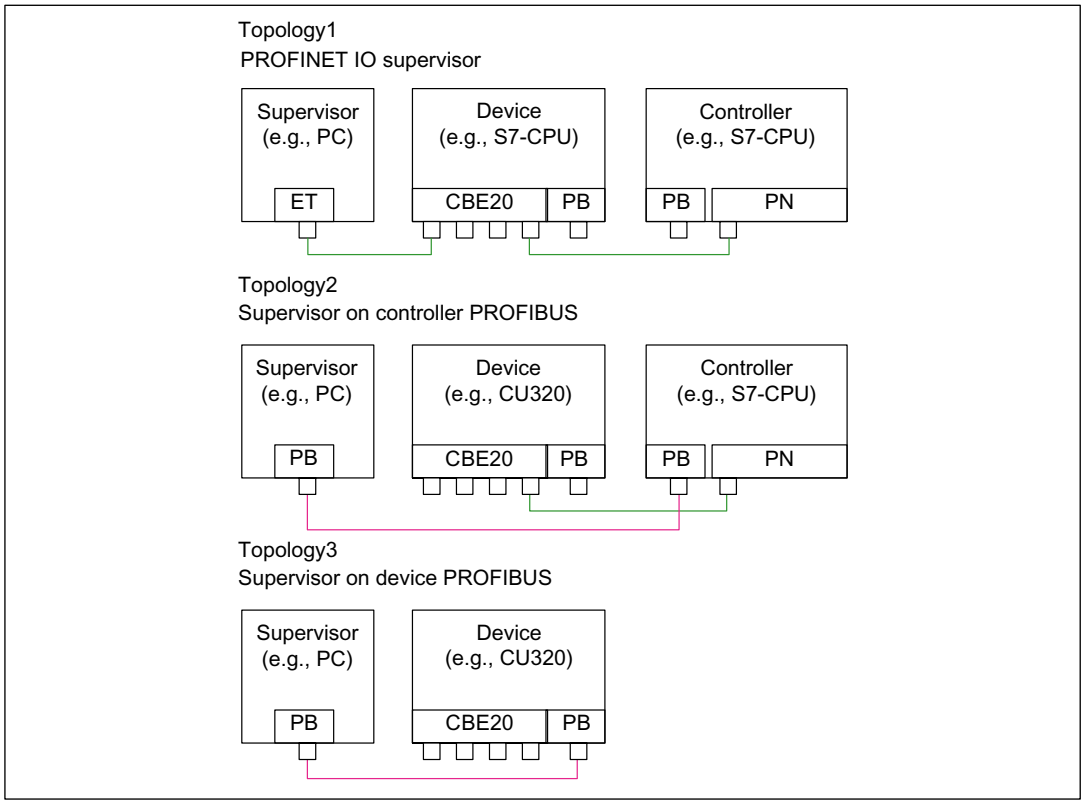


Figure 6-33 Connecting the supervisor

NOTICE
SINAMICS does not support routing from PROFIBUS to PROFINET and vice versa.

NOTICE
If a CBE20 module fails (e.g. due to a power failure) then communication with the subsequent nodes is interrupted at this point.

6.7.5 RT classes

6.7.5.1 RT classes for PROFINET IO

Description

PROFINET IO is a scalable realtime communications system based on Ethernet technology. The scalable approach is expressed with three realtime classes.

RT

The RT communication is based on standard Ethernet. The data is transferred via prioritized Ethernet telegrams.

IRTflex (SW functionality planned for FW2.5 SP1)

The telegrams are sent cyclically in a deterministic cycle (Isochronous Real Time). In so doing, the telegrams are exchanged in a bandwidth reserved by the hardware. One IRT time interval and one standard Ethernet time interval are created for each cycle.

IRTtop

In addition to the bandwidth reservation, the telegram traffic can be further optimized by configuring the topology. This enhances the performance during data exchange and the deterministic behavior. The IRT time interval can thus be further optimized or minimized compared with IRTflex.

In addition to the isochronous data transfer, with IRT even the application (position control cycle, IPO cycle) can be synchronized in the devices. This is an essential requirement for closed-loop axis control and synchronization via the bus.

Table 6-17 Comparison between RT, IRTflex and IRTtop

RT class	RT	IRTflex	IRTtop
Transfer mode	Switching based on the MAC address; prioritization of the RT telegram possible using Ethernet-Prio (VLAN tag).	Switching using the MAC address; bandwidth reservation by reserving an IRTflex interval in which only IRTflex frames are transferred but, for example, no TCP/IP frames.	Path-based switching using a topology-based planning; no transmission of TCP/IP frames in the IRTtop interval.
MinDeviceInterval	Typically 2-8 msec	Typically 1 msec	Fully deterministic, also for 250 µsec
Isochronous application	-	-	Yes
Start time of the isochronous application	-	The times for receiving the data are not scheduled exactly; only the start and end of the interval are fixed.	Times for receving the data scheduled exactly. A synchronous application can be started directly afterwards (similar to DP).

RT class	RT	IRTflex	IRTtop
Determinism	Variance of the transmission duration due to TCP/IP telegrams being underway.	Guaranteed transmission of the IRTflex telegrams in the current cycle by the reserved bandwidth.	Exactly planned transfer; times for transmission and receiving are guaranteed for any topologies.
Reload the network configuration after a change	-	Only when the size of the IRTflex interval needs to be modified (reservation of reserves is possible).	Always when the topology or the communications relationships change.
Cross-traffic (controller-controller):	-	-	Yes
Maximum switching depth (number of switches in one line)	10 at 1 ms	20	20
Synchronization accuracy	-	Forwarding of the sync telegram in software.	Forwarding of the sync telegram in software. accuracy <1 µs)
Possible transmission cycle clocks (observe any device-specific restrictions)	1,000; 2,000; 4,000 µs	500 (planned as of FW2.5 SP1); 1,000; 2,000; 4,000 µs	500 (planned as of FW2.5 SP1)/1,000 – 4,000 µs in increments of 125 µs. The increment depends on the controller.

Set the RT class

The IO controller determines which RT class its IO system supports, by setting the real time class at its controller interface. If IRTtop is set, it is not possible to operate any IRTflex devices on the IO controller and conversely. RT devices can always be operated, even if IRT classes are set.

You can set the RT class in the HW Config for the associated PROFINET device.

1. Double-click the PROFINET board entry in the module in HW Config.

   The **Properties** dialog box is called.

2. Select the realtime class for RT class in the **Synchronization** tab.
3. Click **OK** to confirm.

6.7.5.2 PROFINET IO with RT

PROFINET IO with RT is the optimal solution for the integration of I/O systems without particular requirements in terms of performance and isochronous mode. This is a solution that also uses standard Ethernet in the devices and commercially available industrial switches as infrastructure components. A special hardware support is not required.

Not isochronous

Because standard Ethernet does not support any synchronization mechanisms, isochronous operation is not possible with PROFINET IO with RT!

The realtime capability is comparable with the present PROFIBUS DP solutions with 12 MBaud, whereby a sufficiently large bandwidth portion is available for the parallel transmission of IT services on the same line.

PROFINET IO telegrams have priority over IT telegrams in accordance with IEEE802.1q. This ensures the required determinism in the automation technology.

Data exchange

Communication is possibly only within a network (subnet).

Refresh time

The refresh time is in the range 1 ms, 2 ms and 4 ms. The real refresh time depends on the bus load, the devices used and the quality structure of the I/O data. The refresh time is a multiple of the send clock.

6.7.5.3 Configuring RT communication on Simatic

RT communications with GSDML v1.0

Requirement

For example, a Simatic 300 CPU version <2.5 is configured with a PROFINET sub-network, and a drive is inserted via the GSD file **SINAMICS S120 CBE20 Pilot RT**.

Now, drives and drive objects (DOs) are to be parameterized. For this version of the drive, the telegrams must be inserted step-by-step. To start, a **Parameter Access Point** must be inserted, then a telegram and then again another **Parameter Access Point** - and so on.

Note

The sequence in which the telegram is created must be the same as the sequence of the drive objects in the configuration screen for the drive in STARTER.

Procedure

1. Select the inserted drive in the hardware catalog.
2. Drag the Parameter Access Point entry to slot 1 in the station window of the drive.
3. For the first drive object (DO), drag the appropriate telegram for cyclic data transfer to the next slot of the station window.
4. Repeat steps 2 and 3 for each drive object for which cyclic data is to be exchanged.
5. The project must be saved and compiled once all of the drive objects have been inserted.
6. Assigning the device name.

   Check the "IP address assignment via controller" box for volatile assignment of the IP address for the configured IO controller and IO device during power-up. The configured device name must match the device name of the IO device.
7. Configuration in HW Config is now complete.

RT communications with GSDML v2.0

Requirement

For example, a 300 CPU version 2.5 or higher with a PROFINET IO with RT sub-network has been configured and a drive inserted via the GSD file SINAMICS S120 CBE20.

Now, drives and drive objects (DOs) are to be parameterized. For this version of the GSDML file, the telegrams can be inserted one after the other.

Note

The sequence of the telegram structure must match the sequence of the drive objects in the configuration screen of the drive in STARTER.

Procedure

1. Select the inserted drive in the hardware catalog.
2. For the first drive object (DO), drag the appropriate telegram for cyclic data transfer to the next slot of the station window. A parameter access point is added automatically.
3. Repeat step 2 for each drive object for which cyclic data is to be exchanged.
4. The project must be saved and compiled once all of the drive objects have been inserted.
5. Double-click the drive unit. A dialog containing the properties of the IO device is displayed.

   Check the "IP address assignment via controller" box for volatile assignment of the IP address for the configured IO controller and IO device during power-up. The configured device name must match the device name of the IO device.
6. Configuration in HW Config is now complete.

RT communications with Device OM

Introduction

If the full version of STEP 7 V5.4 is installed on the engineering station (PC), Device OM is installed with STARTER setup.

SIMOTION SCOUT also includes Device OM. The full version of STEP 7 is required, unless SCOUT stand-alone is installed in which case an OEM version of STEP 7 is supplied enabling you to process SIMOTION projects.

SCOUT contains STARTER, which can be used for commissioning drives. This means that SINAMICS drives can also be configured with the SIMATIC CPU and PROFINET. Device OM allows drive objects to be configured in a user-friendly manner (the drive objects automatically include routing information).

Note

In older firmware versions of SIMATIC controllers (e.g. CPU317 PN/DP < V2.4), the GSD files for the drives must still be used.

SIMATIC CPU with SINAMICS drives and PROFINET IO with RT

In our example, we will describe the Device OM in conjunction with the CPU319 and PROFINET IO with RT.

For a list of SIMATIC S7 modules that use Device OM, please contact SIEMENS Product Service.

1. In the hardware catalog, open **PROFINET IO –> Drives –> SINAMICS –> Relevant drive**.

   The available SINAMICS Device OM drive objects are listed. If GSD files have already been installed, a GSD directory is listed too.
2. Select the relevant drive object (DO) and drag it to the appropriate slot in the station window. The CPU slot is now green.
3. Drag the drive object to this slot. The **SINAMICS properties** dialog box is displayed.
4. Keep firmware 2.5 and confirm with OK.
5. Double-click the drive unit. A dialog containing the properties of the IO device is displayed.

   Check the "IP address assignment via controller" box for volatile assignment of the IP address for the configured IO controller and IO device during power-up. The configured device name must match the device name of the IO device.
6. The drive object is inserted with telegram 1 provided as standard. These telegram settings can be changed.
7. Double-click the telegram entry.

   The **Telegram_x** properties dialog box opens.
8. Select the telegram for the drive object.
9. For each drive, insert an additional drive object an configure the appropriate telegram.
10. Configuration of the cyclic telegrams is now complete.

Note

Drive objects without PZD do not transfer process data and are used, for example, to transfer parameters.

6.7.5.4 PROFINET IO with IRT - Overview

Overview

PROFINET IO with IRT is characterized by separate time domains for IRT, RT, and TCP/IP communication. This is safeguarded by high-precision hardware-based cycle monitoring.

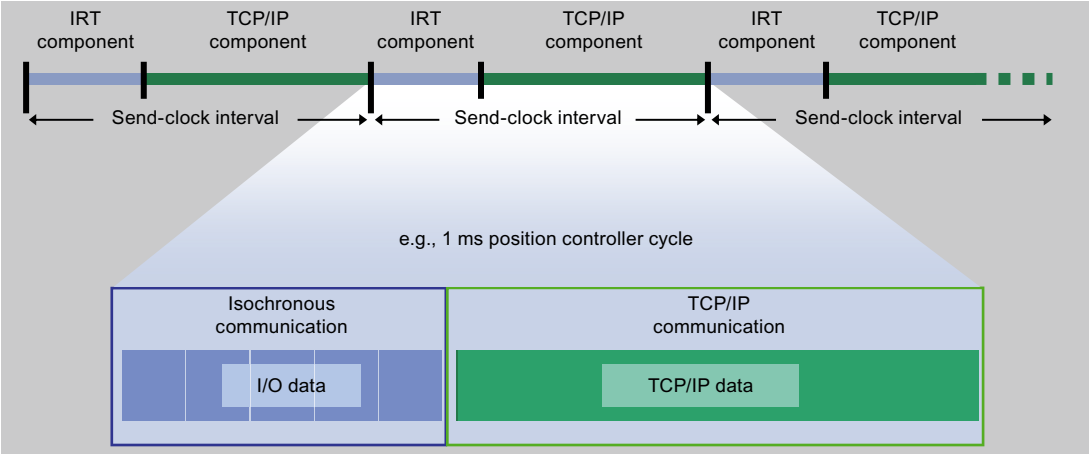


Figure 6-34 IRT Communication - Overview

PROFINET IO with IRT is available in two versions:

- IRTflex (**flex**ible) with fixed bandwidth reservation
- IRTtop (**top** performance) with planned IRT communication

Time synchronization and isochronous mode on PROFINET IO with IRTflex and IRTtop

In addition, a high-performance and isochronous connection to the application with low load on the application CPU is also ensured. Isochronous data transfer with cycle times well below one millisecond and with a deviation in the cycle start (jitter) of less than a microsecond provide sufficient performance reserves for demanding motion control applications.

In contrast to standard Ethernet and PROFINET IO with RT, the telegrams for PROFINET IO with IRT are transmitted based on a schedule.

Sync domain

The sync domain can be configured in HW Config. SINAMICS S120 is an IO device and has to be assigned to a sync master as a sync slave.

6.7.5.5 PROFINET IO with IRTflex

Description

For PROFINET IO with IRTflex, the largest IRT bandwidth requirement of a device plus a reserve for the complete network is reserved. It is not defined when which telegram in the IRT time window over which port will be transferred.

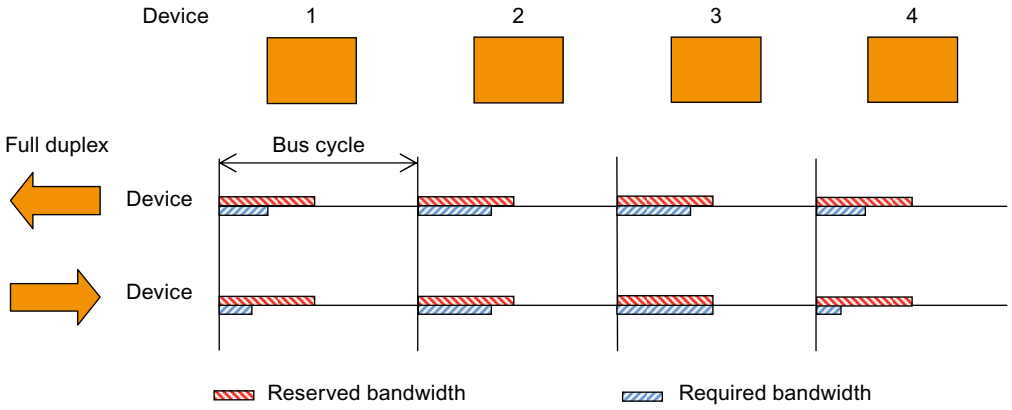


Figure 6-35 Overview of communication with IRTflex

As for PROFINET IO with IRTtop, the synchronization of all devices on a shared Sync master is necessary. All synchronized devices combined form a sync domain.

Send clock

A send clock of 0.5 ms (planned as of FW2.5 SP1))/1.0 ms, 2.0 ms and 4.0 ms can be selected.

Compatibility

A sync domain can only contain either IRTtop devices or IRTflex devices.

The communication between and through different sync domains over PROFINET RT is possible. If no topology is configured, it is not necessary to observe a topology when assembling the devices, as opposed to IRTtop, where devices must connected one to another according to the configured topology.

6.7.5.6 PROFINET IO with IRTtop

The performance capability is significantly increased with PROFINET IRTtop for motion control applications. A hardware support enables a significant increase in performance compared with the present field bus solutions. By planning the telegram traffic in time for IRTtop, a considerable data traffic optimization is achieved compared with IRTflex.

IRTtop is particularly suited for:

- The control and synchronization of axes via PROFINET
- A fast, isochronous I/O integration with short terminal-terminal times

For PROFINET IO with IRTtop, the synchronization of all devices on a shared Sync master is necessary. All synchronized devices combined form a sync domain.

Send clock/Refresh time

Within this time all cyclic and acyclic data (IRTtop data) is transferred. The send clock of 500 µs (planned as of FW2.5 SP1)/1 ms - 4 ms is the maximum range in which the send clock can be set. The actual send clock that can be set depends on various factors:

- The bus traffic load
- The type of devices used
- The computing power available in the controller
- The supported send clocks on the PROFINET devices involved in a sync domain.

A typical send clock is, for example, 1 ms. It can be set in a 125 µs grid within the limits of 500 µs (planned as of FW2.5 SP1)/1 ms to 4 ms.

Time-scheduled data transmission

Scheduling is the specification of the communication paths and the exact transmission times for the data to be transferred. The bandwidth can be optimally utilized through communication scheduling and therefore the best possible performance achieved. The highest determinism quality is achieved through the scheduling of the transmission times which is especially advantageous for an isochronous application connection.

The communication scheduling is performed by the engineering system. An IRT planning algorithm is available for this. The schedule results must be transferred to each IO controller through a download. The IO controller then loads the schedule results into the IO devices during ramp-up. The communication with IRTtop is performed on the basis of these schedule data.

The scheduled data transfer requires a hardware support for PROFINET IO with IRTtop in the form of a communication ASIC (Application Specific Integrated Circuit). In order for scheduled communication not to be put at risk by spontaneously transmitted IT telegrams, a certain proportion of cyclic communication is reserved exclusively for IRTtop transmission. This is called bandwidth reservation. The rest of the communication cycle can be used for RT and IT communication.

Data exchange

Communication is generally also possible via network limits via routers. However, PROFINET IO with IRTtop only runs within a sync domain.

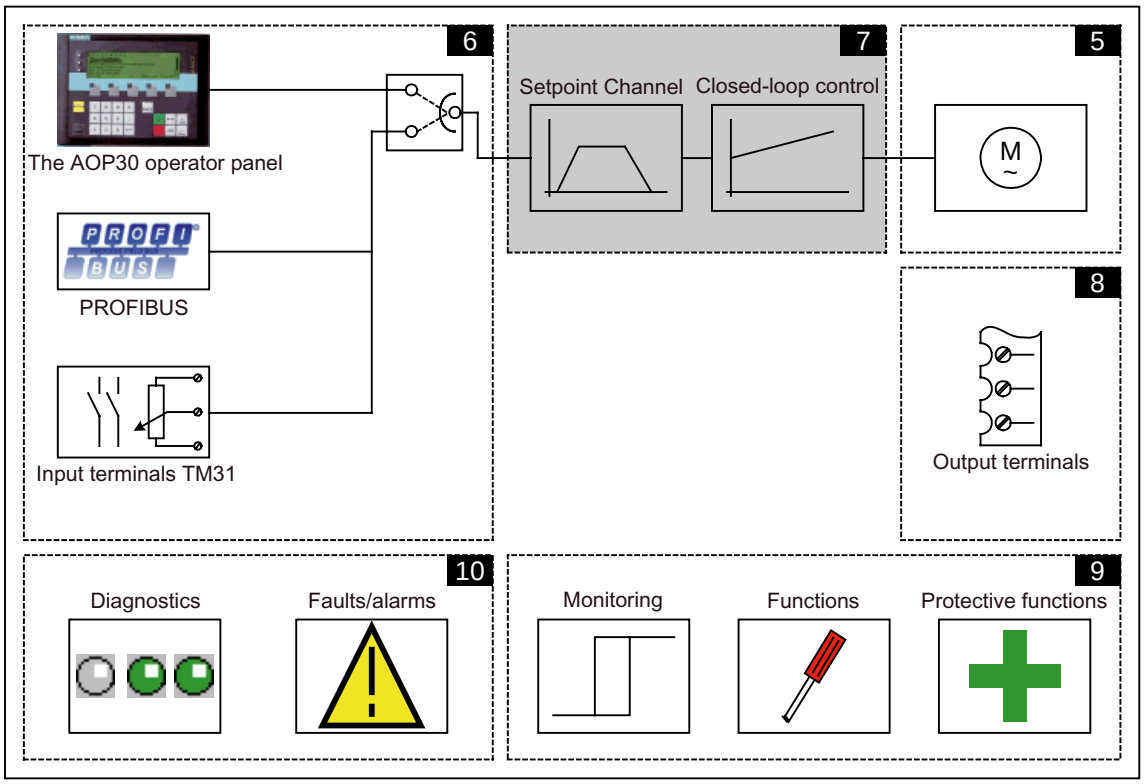
Setpoint channel and closed-loop control

7

7.1 Chapter content

This chapter provides information on the setpoint channel and closed-loop control functions.

- Setpoint channel
  - Direction reversal
  - Skip speed
  - Minimum speed
  - Speed limitation
  - Ramp-function generator
- V/f control
- Speed control with / without encoder



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (7xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the documentation CD in the "SINAMICS G List Manual", which provides experienced users with detailed descriptions of all the functions.

7.2 Setpoint channel

7.2.1 Setpoint addition

Description

The supplementary setpoint can be used to enter correction values from higher-level closed-loop controls. This can be implemented using the summing point of the main/supplementary setpoint in the setpoint channel. Both variables are imported simultaneously via two separate or one setpoint source and added in the setpoint channel.

Function diagram

FD 3030	Main/added setpoint, setpoint scaling, jogging

Parameters

- p1070 Main setpoint
- p1071 Main setpoint scaling
- r1073 Main setpoint effective
- p1075 Supplementary setpoint
- p1076 Supplementary setpoint scaling
- r1077 Supplementary setpoint effective
- r1078 Total setpoint effective

7.2.2 Direction reversal

Description

Due to the direction reversal in the setpoint channel the drive can be operated in both directions.

Use the p110 or p111 parameter to block negative or positive direction of rotation.

Note

If an incorrect rotating field was connected when the cables were installed, and the rotating field cannot be corrected by swapping the motor cables, it can be corrected when commissioning the drive via p1821 (rotating field direction reversal) by changing the rotating field and thus enabling a direction reversal (see section "Direction reversal").

Prerequisites

Direction of rotation changeover is triggered:

- via PROFIBUS by means of control word 1, bit 11
- via the cabinet operator panel (LOCAL mode) with the "direction of rotation changeover" key.

Note

Note that only one direction of rotation is enabled in the factory setting when control is carried out via the AOP30.

Function diagram

FP 3040	Direction of rotation limiting and direction of rotation changeover

Parameters

- p1110 Inhibit negative direction
- p1111 Inhibit positive direction
- p1113 Direction reversal

7.2.3 Skip speeds and minimum speeds

Description

Variable-speed drives can generate critical whirling speeds within the control range of the entire drive train. This prevents steady-state operation in their proximity; in other words, although the drive can pass through this range, it must not remain within it because resonant oscillations may be excited. The skip frequency bands allow this range to be blocked for steady-state operation. Because the points at which critical whirling speeds occur in a drive train can vary depending on age or thermal factors, a broader control range must be blocked. To ensure that the speed does not constantly increase and decrease in the suppression bandwidth (speeds), the bands are assigned a hysteresis.

Specifying a minimum speed allows a specific range to be disabled around speed rpm for steady-state operation.

Signal flow diagram

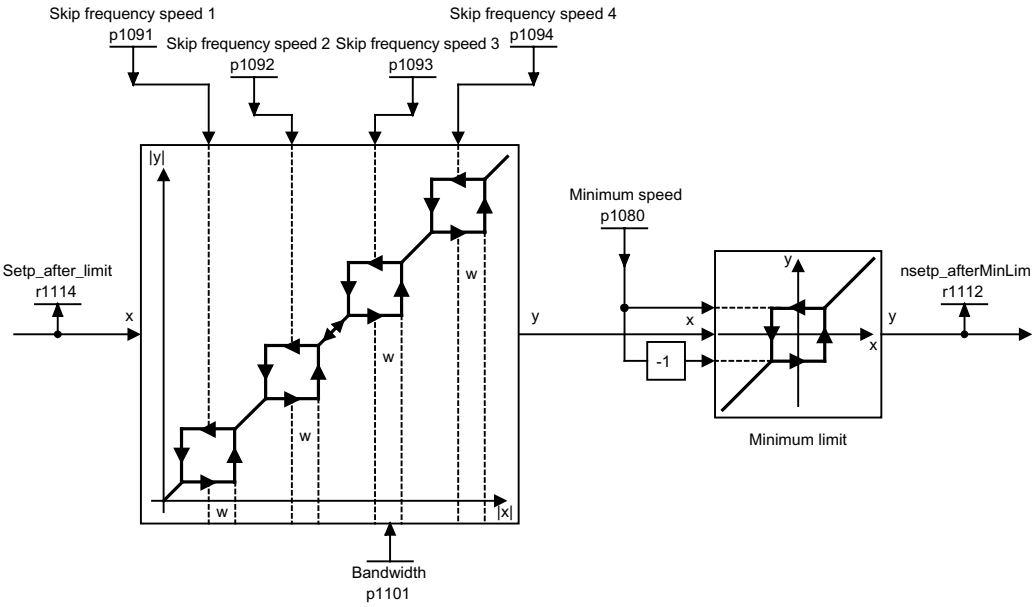


Figure 7-1 Signal flow diagram: Skip frequency speeds and minimum speeds

Function diagram

FP 3050 Skip frequency bands and speed limiting

Parameters

- p1080 Minimum speed
- p1091 Skip frequency speed 1
- p1092 Skip frequency speed 2
- p1093 Skip frequency speed 3
- p1094 Skip frequency speed 4
- p1101 Skip frequency speed bandwidth
- r1112 Speed setpoint after minimum limiting

7.2.4 Speed limitation

Description

Speed limitation aims to limit the maximum permissible speed of the entire drive train to protect the drive and load machine/process against damage caused by excessive speeds.

Signal flow diagram

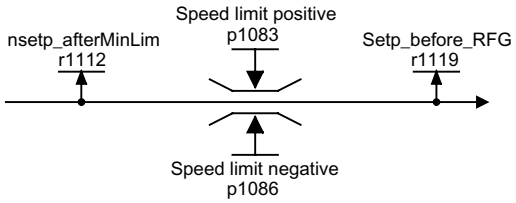


Figure 7-2 Signal flow diagram: Speed limitation

Function diagram

FP 3050 Suppression bandwidth and speed limiting

Parameters

- p1082 Maximum speed
- p1083 Speed limit in positive direction of rotation
- p1086 Speed limit in negative direction of rotation

7.2.5 Ramp-function generator

Description

The ramp-function generator limits the rate at which the setpoint changes when the drive is accelerating or decelerating. This prevents excessive setpoint step changes from damaging the drive train. Additional rounding times can also be set in the lower and upper speed ranges to improve control quality and prevent load surges, thereby protecting mechanical components, such as shafts and couplings.

The ramp-up and ramp-down times each refer to the maximum speed (p1082). The rounding times that can be set can prevent the actual speed value from being overshot when the setpoint is approached, thereby improving control quality.

Notice: if rounding times are too long, this can cause the setpoint to be overshot if the setpoint is reduced abruptly during ramp-up. Rounding is also effective in the zero crossover; in other words, when the direction is reversed, the ramp-function generator output is reduced to zero via initial rounding, the ramp-down time, and final rounding before the new, inverted setpoint is approached via start rounding, the ramp-up time, and end rounding. Rounding times that can be set separately are active in the event of a fast stop (OFF3). The actual ramp-up/ramp-down times increase with active rounding.

The rounding type can be set using p1134 and separately activated/deactivated using p1151.00 in the zero passage.

Signal flow diagram

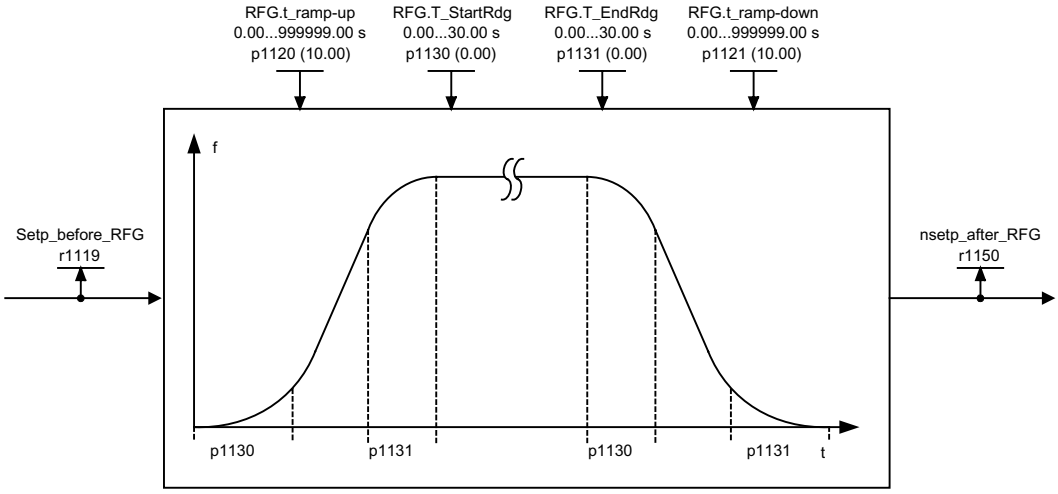


Figure 7-3 Signal flow diagram: Ramp-function generator

Function diagram

FP 3060	Simple ramp-function generator
FP 3060	Extended ramp-function generator

Parameters

- r1119 Ramp-function generator setpoint at the input
- p1120 Ramp-function generator ramp-up time
- p1121 Ramp-function generator ramp-down time
- p1130 Ramp-function generator initial rounding time
- p1131 Ramp-function generator final rounding time
- p1134 Ramp-function generator rounding type
- p1135 OFF3 ramp-down time
- p1136 OFF3 initial rounding time
- p1137 OFF3 final rounding time
- r1150 Ramp-function generator speed setpoint at the output
- p1151 Ramp-function generator configuration

Note

The effective ramp-up time increases when you enter initial and final rounding times.

Effective ramp-up time = p1120 + (0.5 x p1130) + (0.5 x p1131)

7.3 V/f control

Description

The simplest solution for a control procedure is the V/f characteristic, whereby the stator voltage for the induction motor or synchronous motor is controlled proportionately to the stator frequency. This method has proved successful in a wide range of applications with low dynamic requirements, such as:

- Pumps and fans
- Belt drives
- Multi-motor drives

V/f control aims to maintain a constant flux (Φ) in the motor, whereby the flux is proportional to the magnetization current (Iμ) or the ratio of voltage (U) to frequency (f).

Φ ~ Iμ ~ V/f

The torque (M) generated by the induction motors is, in turn, proportional to the product (or, more precisely, the vector product (Φ x I)) of the flux and current.

M ~ Φ x I

To generate as much torque as possible with a given current, the motor must function using the greatest possible constant flux. To maintain a constant flux (Φ), therefore, the voltage (V) must change in proportion to the frequency (f) to ensure a constant magnetization current (Iμ). V/f characteristic control is derived from these basic premises.

The field-weakening range is above the rated motor frequency, where the maximum voltage is reached. The flux and maximum torque decrease as the frequency increases; this is illustrated in the following diagram.

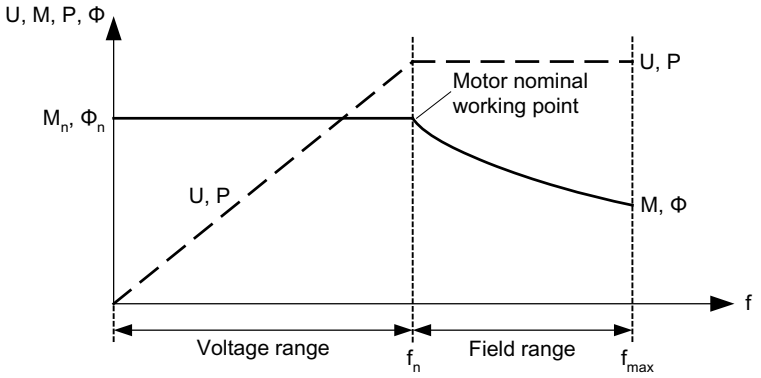
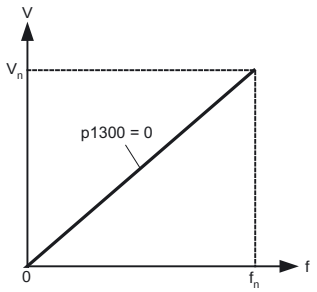
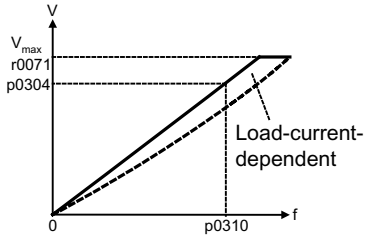
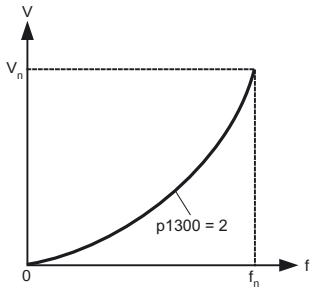
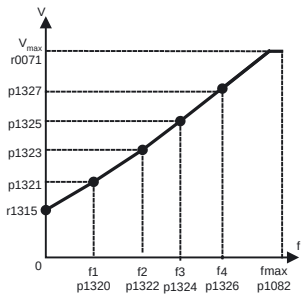


Figure 7-4 Operating areas and characteristic curves for the induction motor with converter supply

Several variations of the V/f characteristic exist, which are listed in the following table.

Table 7-1 p1300 V/f characteristics

Parameter value	Meaning	Application / property	
0	Linear characteristic	Standard with variable voltage boost	
1	Linear characteristic with flux current control (FCC)	Characteristic that compensates for voltage losses in the stator resistance for static / dynamic loads (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.	
2	Parabolic characteristic	Characteristic that takes into account the motor torque curve (e.g. fan/pump). • Quadratic characteristic (f² characteristic) • Energy saving because the low voltage also results in small currents and losses.	
3	Programmable characteristic	Characteristic that takes into account the motor/machine torque characteristic.	
5	Precise frequency drives	Characteristic (see parameter value 0) that takes into account the technological particularity of an application (e.g. textile applications): • Whereby current limitation (Imax controller) only affects the output voltage and not the output frequency. • By disabling slip compensation.	

Parameter value	Meaning	Application / property
6	Precise frequency drives with flux current control (FCC)	Characteristic (see parameter value 1) that takes into account the technological particularity of an application (e.g. textile applications): • Whereby current limitation (Imax controller) only affects the output voltage and not the output frequency. • By disabling slip compensation. Voltage losses in the stator resistance for static / dynamic loads are also compensated (flux current control FCC). This is particularly useful for small motors, since they have a relatively high stator resistance.
19	Independent voltage setpoint	The user can define the output voltage of the Power Module independently of the frequency using BICO parameter p1330 via the interfaces (e.g., analog input AI0 of the TM31 –> p1330 = r4055[0]).

Function diagram

FD 6300 V/f characteristic and voltage boost

Parameter

- p1300 Open-loop/closed-loop control operating mode

7.3.1 Voltage boost

Description

With low output frequencies, the V/f characteristics yield only a small output voltage.

With low frequencies, too, the ohmic resistance of the stator windings has an effect and can no longer be ignored vis-à-vis the machine reactance. With low frequencies, therefore, the magnetic flux is no longer proportional to the magnetization current or the V/f ratio.

The output voltage may, however, be too low to:

- Magnetize the induction motor.
- Maintain the load.
- Compensate for the voltage losses (ohmic losses in the winding resistors) in the system.
- Induce a breakaway / accelerating / braking torque.

You can choose whether the voltage boost is to be active permanently (p1310) or only during acceleration (p1311).

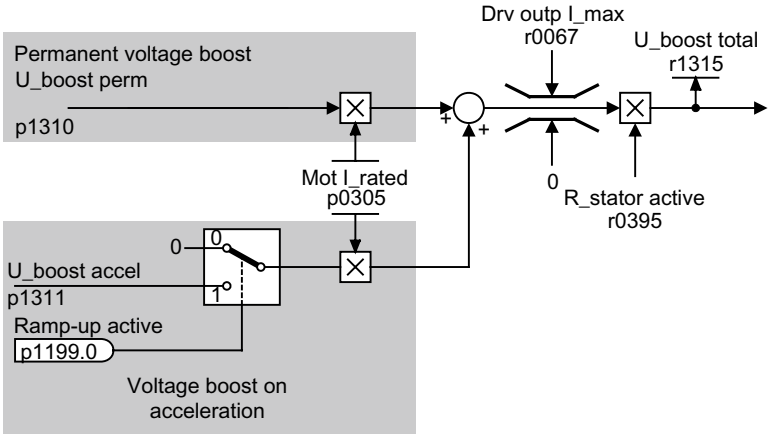


Figure 7-5 Voltage boost total

Note

The voltage boost affects all V/f characteristics (p1300) from 0 to 6.

NOTICE
If the voltage boost value is too high, this can result in a thermal overload of the motor winding.

Permanent voltage boost (p1310)

The voltage boost is active across the entire frequency range, whereby the value decreases continuously as the frequency increases.

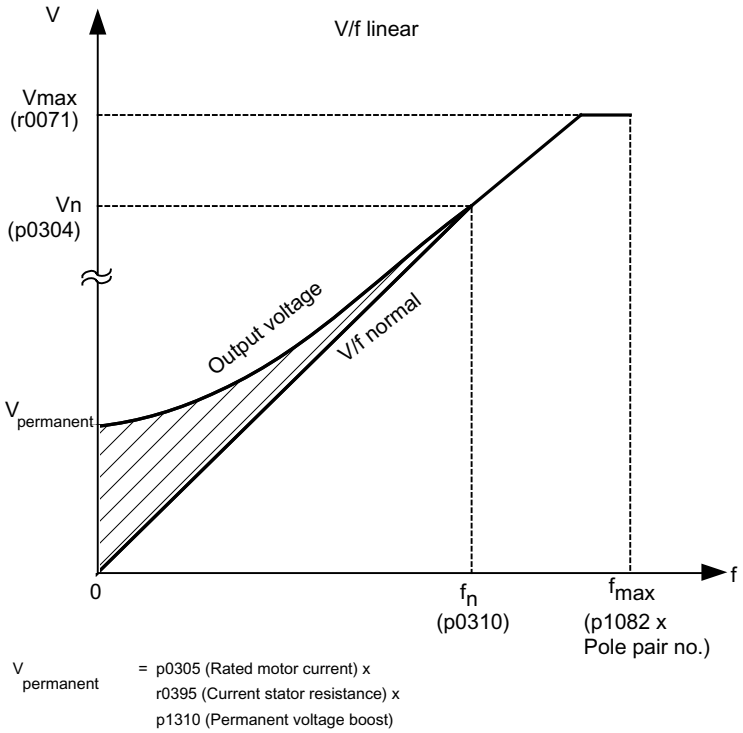


Figure 7-6 Permanent voltage boost (example: p1300 = 0, p1310 >0, p1311 = 0)

Voltage boost during acceleration (p1311)

Voltage boost is only active during acceleration or braking. Voltage boost is only active if the "Ramp-up active" signal (r1199.0 = 1) is pending.

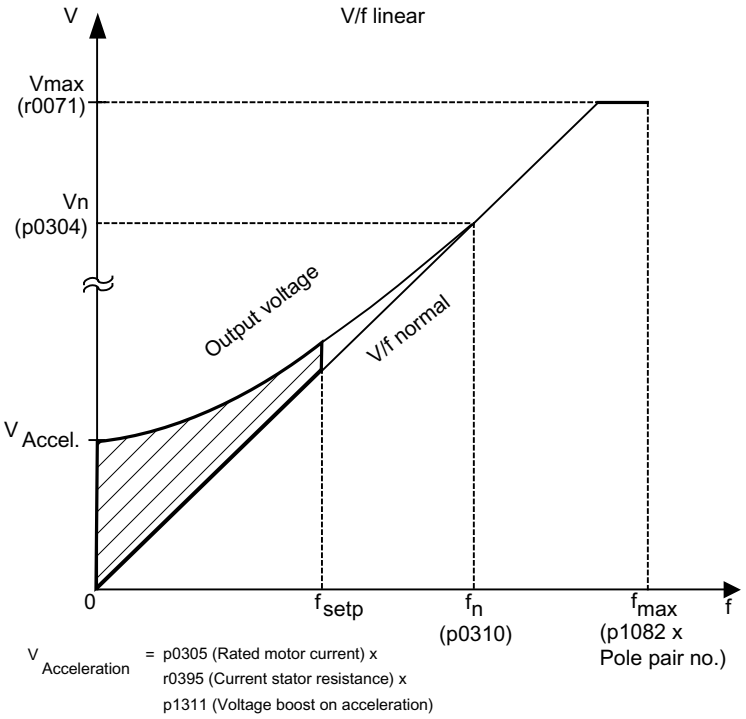


Figure 7-7 Voltage boost during acceleration (example: p1300 = 0, p1310 = 0, p1311 > 0)

Function diagram

FP 6300 V/f characteristic and voltage boost

Parameters

- p0304 Rated motor voltage
- p0305 Rated motor current
- r0395 Stator resistance, actual
- p1310 Permanent voltage boost
- p1311 Voltage boost during acceleration
- r1315 Voltage boost total

7.3.2 Slip compensation

Description

The slip compensation means that the speed of induction motors is essentially kept constant independent of the load.

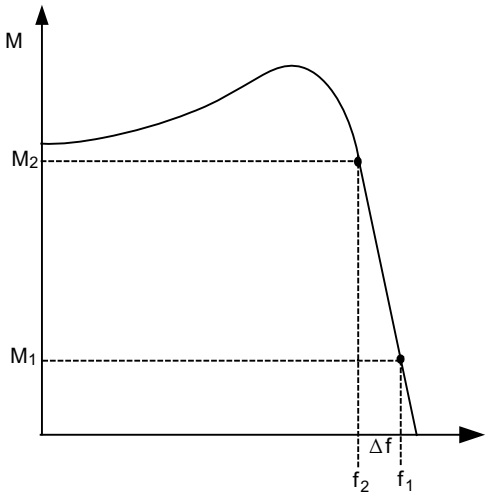


Figure 7-8 Slip compensation

Function diagram

FP 6310 Resonance damping and slip compensation

Parameters

- p1335 Slip compensation
  p1335 = 0.0 %: slip compensation is deactivated.
  p1335 = 100.0 %: slip is fully compensated.
- p1336 Slip compensation limit value
- r1337 Actual slip compensation

7.4 Vector speed/torque control with/without encoder

Description

Compared with V/f control, vector control offers the following benefits:

- Stability vis-à-vis load and setpoint changes
- Short rise times with setpoint changes (–> better command behavior)
- Short settling times with load changes (–> better disturbance characteristic)
- Acceleration and braking are possible with maximum adjustable torque
- Motor protection due to variable torque limitation in motor and regenerative mode
- Drive and braking torque controlled independently of the speed

These benefits are available without speed feedback.

Vector control can be used with or without an encoder.

The following criteria indicate when an encoder is required:

- Maximum speed accuracy requirements
- Maximum dynamic response requirements
  - Better command behavior
  - Shortest settling times when disturbances occur
- Torque control is required in a control range greater than 1:10
- Allows a defined and/or variable torque for speeds below approx. 10% of the rated motor frequency (p0310) to be maintained.

With regard to setpoint input, vector control is divided into:

- Speed control
- Torque/current control (in short: torque control)

7.4.1 Vector control without encoder

Description

For vector control without encoder only (SLVC: Sensorless Vector Control), the position of the flux and actual speed must be determined via the electric motor model. The model is buffered by the incoming currents and voltages. At low frequencies (approx. 0 Hz), the model cannot determine the speed.

For this reason and due to uncertainties in the model parameters or inaccurate measurements, the system is switched from closed-loop to open-loop operation in this range.

The changeover between closed-loop/open-loop operation is controlled on the basis of time and frequency conditions (p1755, p1756, p1758 - only for induction motors). The system does not wait for the time condition to elapse if the setpoint frequency at the ramp-function generator input and the actual frequency are below p1755 x (1 - (p1756 / 100 %)) simultaneously.

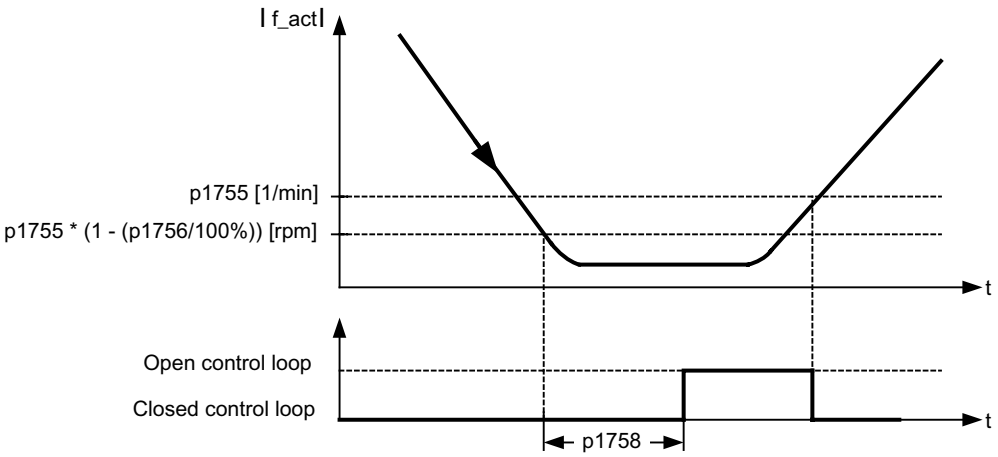


Figure 7-9 Switchover conditions

In open-loop operation, the calculated actual speed value is the same as the setpoint value. For vertical loads and acceleration processes, parameters p1610 (constant torque boost) and p1611 (acceleration torque boost) must be modified in order to generate the static or dynamic load torque of the drive. If, on induction motors, p1610 is set to 0%, only the magnetizing current r0331 is injected; at a value of 100%, the rated motor current p0305 is injected. For permanent-magnet synchronous motors, at p1610 = 0%, a pre-control absolute value derived from the supplementary torque r1515 remains instead of the magnetizing current. To ensure that the drive does not stall during acceleration, p1611 can be increased or acceleration pre-control for the speed controller can be used. This is also advisable to ensure that the motor is not subject to thermal overload at low speeds.

Vector control without a speed sensor has the following characteristics at low frequencies:

- Closed-loop operation up to approx. 1 Hz output frequency
- Starting in closed-loop operation (directly after the drive has been energized) (induction motors only)

Note

In this case, the speed setpoint upstream of the ramp-function generator must be greater than (p1755).

Closed-loop operation up to approx. 1 Hz (settable via parameter p1755) and the ability to start or reverse at 0 Hz directly in closed-loop operation (settable via parameter p1750) result in the following benefits:

- No switchover required within closed-loop control (smooth operation, no dips in frequency).
- Stationary speed–torque control up to approx. 1 Hz.

Note

When the motor is started or reversed in closed-loop control mode at 0 Hz, you must remember that a switchover is made from closed-loop to open-loop control automatically if the system remains in the 0 Hz range for too long (> 2 s or > p1758).

Permanent-magnet synchronous motors are always started and reversed in open-loop operation. The changeover speeds are set to 10% or 5% of the rated motor speed. Changeover is not subject to any time condition (p1758 is not evaluated). Prevailing load torques (motor or regenerative) are adapted in open-loop operation, facilitating constant-torque crossover to closed-loop operation even under high static loads. Whenever the pulses are enabled, the rotor position is identified.

Function diagram

FD 6730	Interface to Motor Module

Parameter

- p0305 Rated motor current
- r0331 Motor magnetizing current/short-circuit current
- p1610 Torque setpoint static (SLVC)
- p1611 Supplementary accelerating torque (SLVC)
- p1750 Motor model configuration
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis
- p1758 Motor model changeover delay time, closed/open-loop control
- p1759 Motor model changeover delay time open/closed loop control

7.4.2 Vector control with encoder

Description

Benefits of vector control with an encoder:

- The speed can be controlled right down to 0 Hz (standstill)
- Stable control response throughout the entire speed range
- Allows a defined and/or variable torque for speeds below approx. 10 % of the rated motor speed to be maintained
- Compared with speed control without an encoder, the dynamic response of drives with an encoder is significantly better because the speed is measured directly and integrated in the model created for the current components.

Motor model change

A model change takes place between the current model and the observer model within the speed range p1752 x (100 % - p1756) and p1752. In the current-model range (i.e., at lower speeds), torque accuracy depends on whether thermal tracking of the rotor resistance is carried out correctly. In the observer-model range and at speeds of less than approx. 20% of the rated speed, torque accuracy depends primarily on whether thermal tracking of the stator resistance is carried out correctly. If the resistance of the supply cable is greater than 20% to 30 % of the total resistance, this should be entered in p0352 before motor data identification is carried out (p1900/p1910).

To deactivate thermal adaptation, set p0620 = 0. This may be necessary if adaptation cannot function accurately enough due to the following supplementary conditions: For example, if a KTY sensor is not used for temperature detection and the ambient temperatures fluctuate significantly or the overtemperatures of the motor (p0626 ... p0628) deviate significantly from the default settings due to the design of the motor.

Function diagram

FP 4715	Actual speed value and rotor position measurement, motor encoder
FD 6030	Speed setpoint, droop
FP 6040	Speed controller
FP 6050	Kp_n-/Tn_n adaptation
FP 6060	Torque setpoint
FP 6490	Speed control configuration

7.4.3 Speed controller

Description

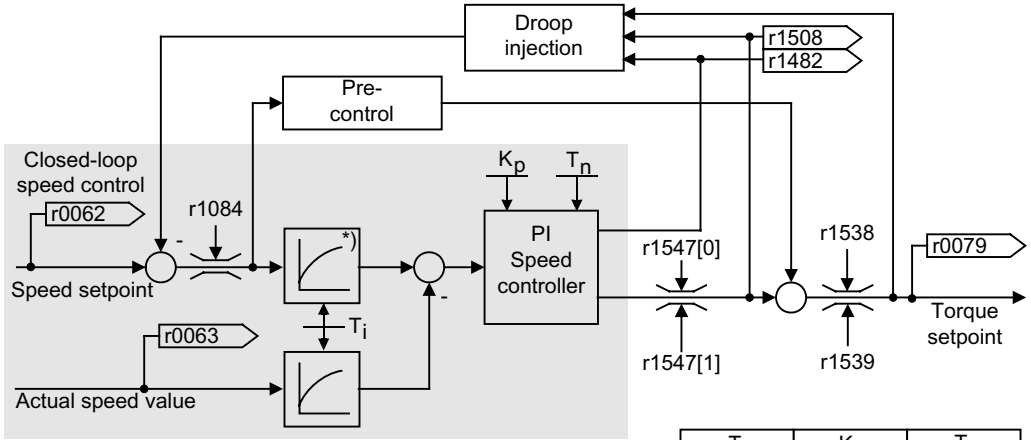
Both closed-loop control techniques with and without encoder (SLVC, VC) have the same speed controller structure that contains the following components as kernel:

- PI controller
- Speed controller pre-control
- Droop Function

The torque setpoint is generated from the total of the output variables and reduced to the permissible magnitude by means of torque setpoint limitation.

The speed controller receives its setpoint (r0062) from the setpoint channel and its actual value (r0063) either directly from the speed actual value encoder (vector control with encoder) or indirectly via the motor model (encoderless vector control). The system difference is increased by the PI controller and, in conjunction with the pre-control, results in the torque setpoint.

When the load torque increases, the speed setpoint is reduced proportionately when the droop function is active, which means that the single drive within a group (two or more mechanically connected motors) is relieved when the torque becomes too great.



*) only active if pre-control is active (p1496 > 0)

	T_i	K_p	T_n
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-10 Speed controller

The optimum speed controller setting can be determined via the automatic speed controller optimization function (p1900 = 1, rotating measurement).

If the moment of inertia has been specified, the speed controller (Kp, Tn) can be calculated by means of automatic parameterization (p0340 = 4). The controller parameters are defined in accordance with the symmetrical optimum as follows:

Tn = 4 x Ts

Kp = 0.5 x r0345 / Ts = 2 x r0345 / Tn

Ts = Sum of the short delay times (includes p1442 and p1452).

If vibrations occur with these settings, the speed controller gain (Kp) will need to be reduced manually. Actual-speed-value smoothing can also be increased (standard procedure for gearless or high-frequency torsion vibrations) and the controller calculation performed again because this value is also used to calculate Kp and Tn.

The following relationships apply for optimization:

- Increasing Kp will speed up the controller and reduce overshoot. However, signal ripples and vibrations in the speed control loop will increase.
- Although reducing Tn will also speed up the controller, it will increase overshoot.

When setting speed control manually, you are advised to define the dynamic response via Kp (and actual-speed-value smoothing) first, so that the integral time can subsequently be reduced as much as possible. Please remember that closed-loop control must also remain stable in the field-weakening range.

To suppress any vibrations that occur in the speed controller, it is usually only necessary to increase the smoothing time in p1452 for operation without an encoder or p1442 for operation with an encoder, or reduce the controller gain.

The integral output of the speed controller can be monitored via r1482 and the limited controller output via r1508 (torque setpoint).

Note

In comparison with speed control with an encoder, the dynamic response of drives without an encoder is significantly reduced. The actual speed is derived by means of a model calculation based on the converter output variables for current and voltage that have a corresponding interference level. To this end, the actual speed must be adjusted by means of filter algorithms in the software.

Function diagram

FP 6040	Speed controller

Parameters

- r0062 CO: Speed setpoint after the filter
- r0063 CO: Actual speed value smoothed
- p0340 Automatic calculation, control parameters
- r0345 CO: Rated motor startup time
- p1442 Speed-actual-value smoothing time (VC)
- p1452 Speed-actual-value smoothing time (encoderless VC)
- p1460 Speed controller P gain with encoder
- p1462 Speed controller integral time with encoder
- p1470 Speed controller encoderless operation P gain
- p1472 Speed controller encoderless operation integral time
- r1482 CO: Torque output I speed controller
- r1508 CO: Torque setpoint before supplementary torque
- p1960 Speed controller optimization selection

Examples of speed controller settings

A few examples of speed controller settings with vector control without encoders (p1300 = 20) are provided below. These should not be considered to be generally valid and must be checked in terms of the control response required.

- **Fans (large centrifugal masses) and pumps**

  Kp (p1470) = 2 … 10

  Tn (p1472) = 250 … 500 ms

  The Kp = 2 and Tn = 500 ms settings result in asymptotic approximation of the actual speed to the setpoint speed after a setpoint step change. During many simple control procedures, this is satisfactory for pumps and fans.

- **Stone mills, separators (large centrifugal masses)**

  Kp (p1470) = 12 … 20

  Tn (p1472) = 500 … 1000 ms

- **Kneader drives**

  Kp (p1470) = 10

  Tn (p1472) = 200 … 400 ms

Note

We recommend checking the effective speed control gain (r1468) during operation. If this value changes during operation, the Kp adaptation is being used (p1400.5 = 1). Kp adaptation can if necessary be deactivated or its behavior changed.

- **When operating with encoder (p1300 = 21)**

  A smoothing value for the actual speed value (p1442) = 5 … 20 ms ensures quieter operations for motors with gear units.

7.4.3.1 Speed controller pre-control (integrated pre-control with balancing)

Description

The command behavior of the speed control loop can be improved by calculating the accelerating torque from the speed setpoint and connecting it on the line side of the speed controller. This torque setpoint mv is applied to the current controller/the current controller is pre-controlled using adaptation elements directly as additive reference variable (enabled via p1496).
The torque setpoint (mv) is calculated from:

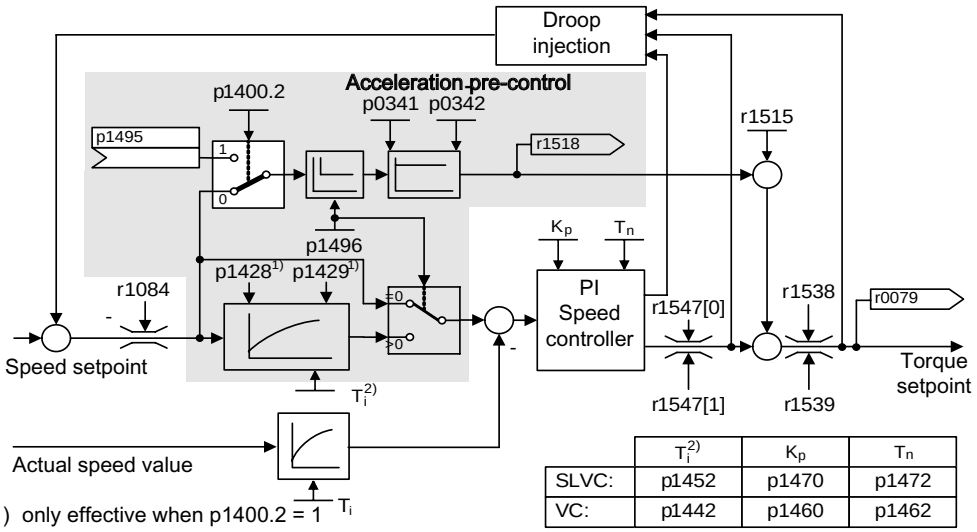
$mv = p1496 \times J \times (d\omega/dt) = p1496 \times p0341 \times p0342 \times (d\omega/dt)$, $\omega = 2\pi f$

The motor moment of inertia p0341 is calculated when commissioning the drive system. The factor p0342 between the total moment of inertia J and the motor moment of inertia must be determined manually or by optimizing the speed controller.

Note

When speed controller optimization is carried out, the ratio between the total moment of inertia and that of the motor (p0342) is determined and acceleration pre-control scaling (p1496) is set to 100 %.

If p1400.2 = p1400.3 = 0, then the pre-control balancing is automatically set.



	T_i 2)	K_p	T_n
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-11 Speed controller with pre-control

When correctly adapted, when accelerating, the speed controller only has to compensate disturbance variables in its control loop. This is achieved with a relatively minor controlled variable change at the controller output. Speed-setpoint changes, on the other hand, are carried out without involving the speed controller and are, therefore, achieved more quickly.

The effect of the pre-control variable can be adapted according to the application using the weighting factor p1496. For p1496 = 100%, pre-control is calculated according to the motor and load moment of inertia (p0341, p0342). A balancing filter is used automatically to prevent the speed controller acting against the injected torque setpoint. The time constant of the balancing filter corresponds to the equivalent delay time of the speed control loop. Speed controller pre-control is correctly set (p1496 = 100%, calibration using p0342) if the I component of the speed controller (r1482) does not change while ramping-up or ramping-down in the range n > 20% x p0310. Thus, pre-control allows a new speed setpoint to be approached without overshoot (prerequisite: torque limiting does switch in and the moment of inertia remains constant).

If the speed controller is pre-controlled by means of injection, the speed setpoint (r0062) is delayed with the same smoothing time (p1442 or p1452) as the actual value (r1445). This ensures that no target/actual difference (r0064) occurs at the controller input during acceleration, which would be attributable solely to the signal propagation time.

When speed pre-control is activated, the speed setpoint must be specified continuously or without a higher interference level (avoids sudden torque changes). An appropriate signal can be generated by smoothing the speed setpoint or activating ramp-function generator rounding p1130 – p1131.

The startup time r0345 ($T_{startup}$) is a measure for the total moment of inertia J of the machine and describes the time during which the unloaded drive can be accelerated with the rated motor torque r0333 ($M_{mot,rated}$) from standstill to the rated motor speed p0311 ($n_{mot,rated}$).

r0435 = $T_{startup}$ = J x (2 x π x $n_{mot,rated}$) / (60 x $M_{mot, rated}$) = p0341 x p0342 x (2 x π x p0311) / (60 x r0333)

If these supplementary conditions are in line with the application, the startup time can be used as the lowest value for the ramp-up or ramp-down time.

Note

The ramp-up and ramp-down times (p1120; p1121) of the ramp-function generator in the setpoint channel should be set accordingly so that the motor speed can track the setpoint during acceleration and braking. This will optimize the function of speed controller pre-control.

Acceleration pre-control using a connector input (p1495) is activated by the parameter settings p1400.2 = 1 and p1400.3 = 0. p1428 (dead time) and p1429 (time constant) can be set for balancing purposes.

Function diagram

FP 6031	Pre-control balancing reference/acceleration model

Parameters

- p0311 Rated motor speed
- r0333 Rated motor torque
- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- r0345 Rated motor startup time
- p1400.2 Acceleration pre-control source
- p1428 Speed pre-control balancing dead time
- p1429 Speed pre-control balancing time constant
- p1496 Acceleration pre-control scaling
- r1518 Acceleration torque

7.4.3.2 Reference model

Description

The reference model becomes operative when p1400.3 = 1 and p1400.2 = 0.

The reference model is used to emulate the speed control loop with a P speed controller.

The loop emulation can be set in p1433 to p1435. It becomes effective if p1437 is connected to the output of the model r1436.

The reference model delays the setpoint-actual value deviation for the integral component of the speed controller so that settling (stabilizing) operations can be suppressed.

The reference model can also be externally emulated and the external signal entered via p1437.

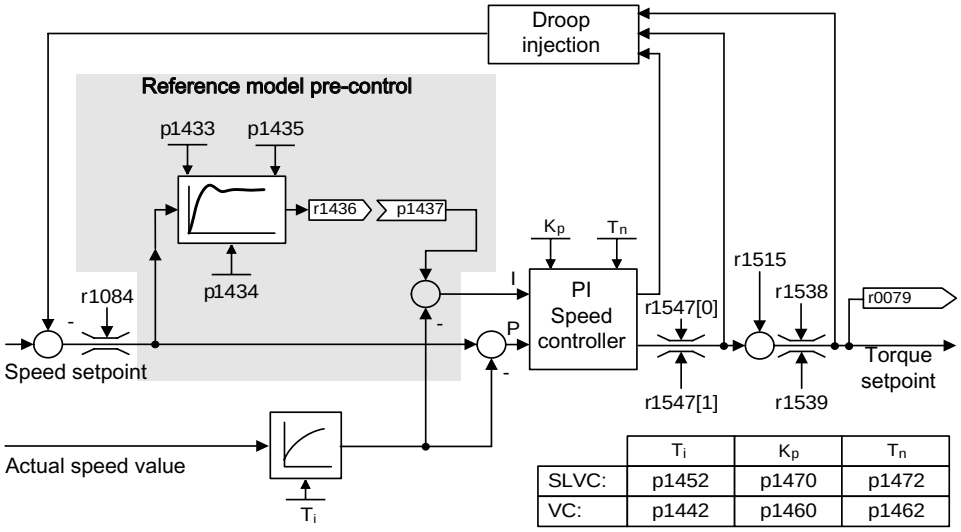


Figure 7-12 Reference model

Function diagram

FP 6031 Pre-control balancing reference/acceleration model

Parameters

- p1400.3 Reference model speed setpoint I component
- p1433 Speed controller reference model natural frequency
- p1434 Speed controller reference model damping
- p1435 Speed controller reference model dead time
- r1436 Speed controller reference model speed setpoint output
- p1437 Speed controller reference model I component input

7.4.3.3 Speed controller adaptation

Description

Two adaptation methods are available, namely free Kp_n adaptation and speed-dependent Kp_n/Tn_n adaptation.

Free Kp_n adaptation is also active in "operation without encoder" mode and is used in "operation with encoder" mode as an additional factor for speed-dependent Kp_n adaptation.

Speed-dependent Kp_n/Tn_n adaptation is only active in "operation with encoder" mode and also affects the Tn_n value.

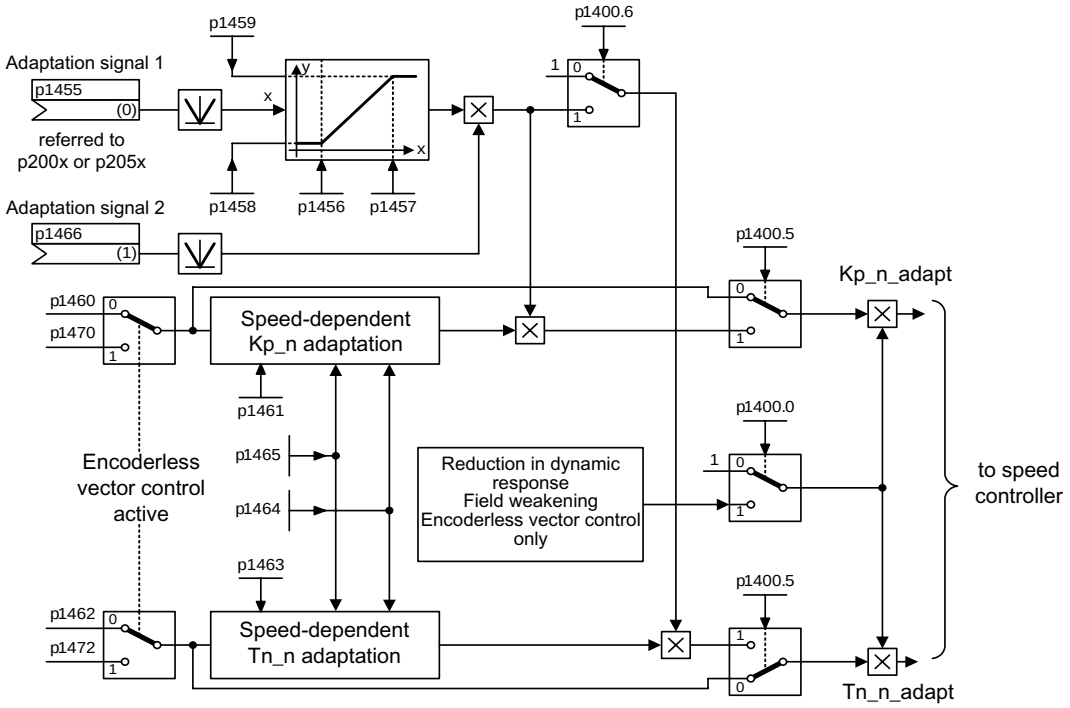


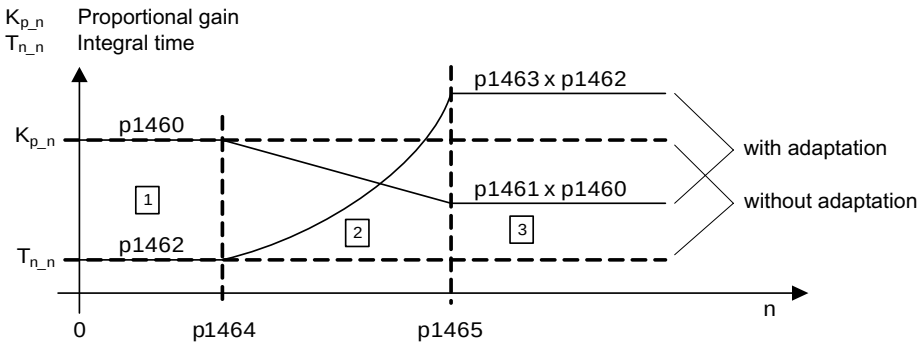
Figure 7-13 Free Kp adaptation

A dynamic response reduction in the field-weakening range can be activated in encoderless operation (p1400.0). This is activated when the speed controller is optimized in order to achieve a greater dynamic response in the base speed range.

Example of speed-dependent adaptation

Note

This type of adaptation is only active in "operation with encoder" mode.



1	Constant lower speed range	(n < p1464)
2	Adaptation range	(p1464 < n < p1465)
3	Constant upper speed range	(n > p1465)

Figure 7-14 Example of speed-dependent adaptation

Function diagram

FP 6050 Kp_n-/Tn_n adaptation

Parameters

- p1400.5 Speed control configuration: Kp/Tn adaptation active

Free Kp_n adaptation

- p1455 Speed controller P gain adaptation signal
- p1456 Speed controller P gain adaptation lower starting point
- p1457 Speed amplifier P gain adaptation upper starting point
- p1458 Adaptation factor lower
- p1459 Adaptation factor upper
- p1470 Speed controller encoderless operation P gain

Speed-dependent Kp_n/Tn_n adaptation (VC only)

- p1460 Speed controller P gain adaptation speed lower
- p1461 Speed controller P gain adaptation speed upper
- p1462 Speed controller integral time adaptation speed lower
- p1463 Speed controller integral time adaptation speed upper
- p1464 Speed controller adaptation speed lower
- p1465 Speed controller adaptation speed upper
- p1466 Speed controller P gain scaling

Dynamic response reduction field weakening (encoderless VC only)

- p1400.0 Speed control configuration: Automatic Kp/Tn adaptation active

7.4.3.4 Droop Function

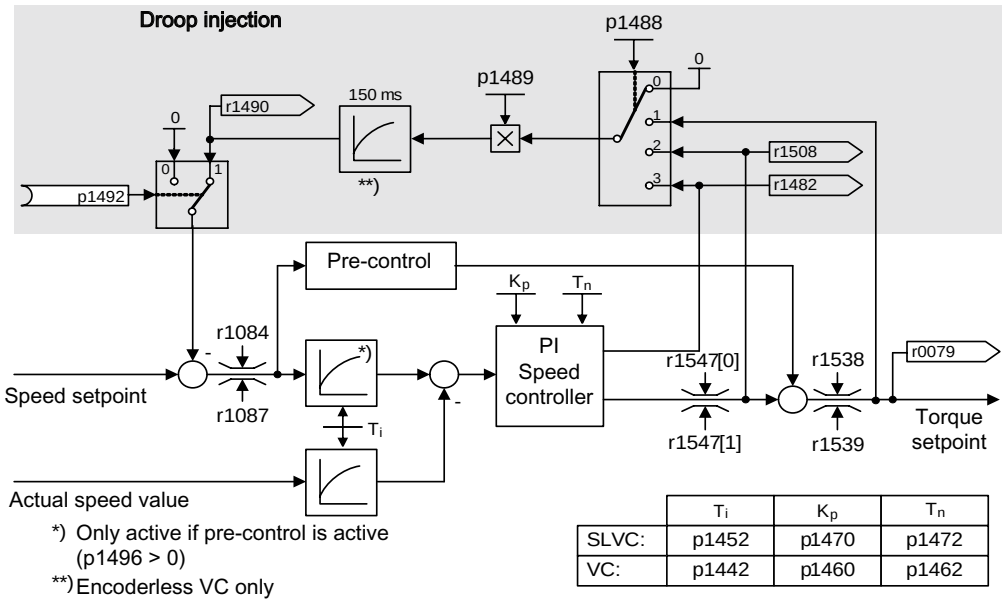
Description

Droop (enabled via p1492) ensures that the speed setpoint is reduced proportionally as the load torque increases.

The droop function has a torque limiting effect on a drive that is mechanically coupled to a different speed (e.g. guide roller on a goods train). In this way, a very effective load distribution can also be realized in connection with the torque setpoint of a leading speed-controlled drive. In contrast to torque control or load distribution with overriding and limitation, when using an the appropriate setting, such a load distribution controls even a smooth mechanical connection or the case of slipping.

This method is only suitable to a limited extent for drives that are accelerated and braked with significant changes in speed.

The droop feedback is used, for example, in applications in which two or more motors are connected mechanically or operate with a common shaft and fulfill the above requirements. It limits the torque differences that can occur as a result of the mechanical connection between the motors by modifying the speeds of the individual motors (drive is relieved when the torque becomes too great).



	Ti	Kp	Tn
SLVC:	p1452	p1470	p1472
VC:	p1442	p1460	p1462

Figure 7-15 Speed controller with droop

Requirement

- All connected drives must be operated with vector and speed control (with or without speed actual value encoder).
- Only one single common ramp function generator may be used for mechanically coupled drives.

Function diagram

FP 6030 Speed setpoint, droop

Parameters

- r0079 Total speed setpoint
- r1482 Speed controller I torque output
- p1488 Droop input source
- p1489 Droop feedback scaling
- r1490 Droop feedback speed reduction
- p1492 Droop feedback enable
- r1508 Torque setpoint before supplementary torque

7.4.4 Closed-loop torque control

Description

For sensorless closed-loop speed control (p1300 = 20) or closed-loop speed control with encoder VC (p1300 = 21), it is possible to change over to closed-loop torque control using BICO parameter p1501. It is not possible to change over between closed-loop speed and torque control if closed-loop torque control is directly selected with p1300 = 22 or 23. The torque setpoint and/or supplementary setpoint can be entered using BICO parameter p1503 (CI: torque setpoint) or p1511 (CI: supplementary torque setpoint). The supplementary torque acts both for closed-loop torque as well as for the closed-loop speed control. As a result of this characteristic, a pre-control torque can be implemented for the closed-loop speed control using the supplementary torque setpoint.

Note

For safety reasons, assignments to fixed torque setpoints are currently not possible.

If energy is regenerated and cannot be injected back into the line supply, then a Braking Module with connected braking resistor must be used.

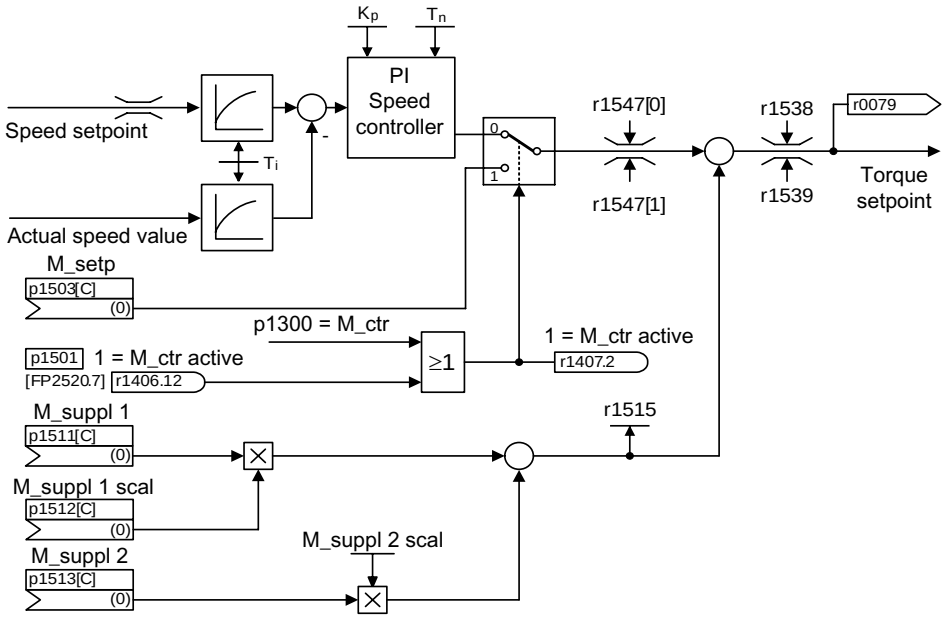


Figure 7-16 Closed-loop speed/torque control

The total of the two torque setpoints is limited in the same way as the speed control torque setpoint. Above the maximum speed (p1082), a speed limiting controller reduces the torque limits in order to prevent the drive from accelerating any further.

A "real" closed-loop torque control (with a speed that automatically sets itself) is only possible in the closed-loop control range but not in the open-loop control range of the sensorless closed-loop vector control. In the open-loop controlled range, the torque setpoint changes the setpoint speed via a ramp-up integrator (integrating time ~ p1499 x p0341 x p0342). This is the reason that sensorless closed-loop torque control close to standstill is only suitable for applications that require an accelerating torque there and no load torque (e.g. traversing drives). Closed-loop torque control with encoder does not have this restriction.

OFF responses

- OFF1 and p1300 = 22, 23
  - Response as for OFF2
- OFF1, p1501 = "1" signal and p1300 ≠ 22, 23
  - No separate braking response; the braking response is provided by a drive that specifies the torque.
  - The pulses are inhibited when the brake application time (p1217) expires. Standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Switching on inhibited is activated.

- OFF2
  - Immediate pulse suppression, the drive coasts to standstill.
  - The motor brake (if parameterized) is closed immediately.
  - Switching on inhibited is activated.
- OFF3
  - Switch to speed-controlled operation
  - n_set = 0 is input immediately to brake the drive along the OFF3 deceleration ramp (p1135).
  - When standstill is detected, the motor brake (if parameterized) is closed.
  - The pulses are inhibited when the motor brake closing time (p1217) has elapsed. Standstill is detected when the speed actual value of the speed threshold (p1226) is undershot or when the monitoring time (p1227) started when speed setpoint ≤ speed threshold (p1226) expires.
  - Switching on inhibited is activated.

Function diagram

FP 6060 Torque setpoint

Parameters

- p0341 Motor moment of inertia
- p0342 Ratio between the total and motor moment of inertia
- p1300 Open-loop/closed-loop control mode
- p1499 Accelerating for torque control, scaling
- p1501 Change over between closed-loop speed/torque control
- p1503 Torque setpoint
- p1511 Supplementary torque 1
- p1512 Supplementary torque 1 scaling
- p1513 Supplementary torque 2
- p1514 Supplementary torque 2 scaling
- r1515 Supplementary torque total

7.4.5 Torque limiting

Description

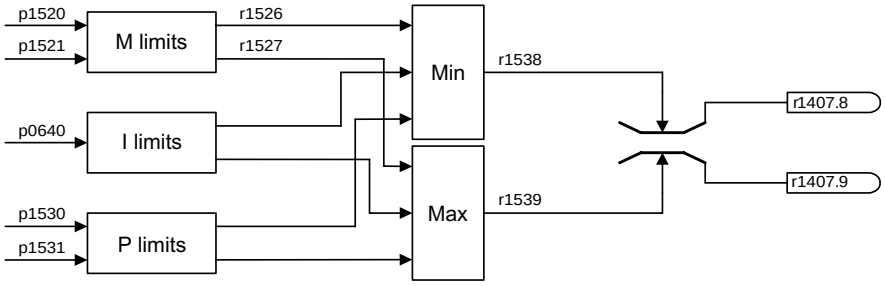


Figure 7-17 Torque limiting

The value specifies the maximum permissible torque whereby different limits can be parameterized for motor and regenerative mode.

- p0640 Current limit
- p1520 Torque limit, upper/motoring
- p1521 Torque limit, lower/regenerative
- p1522 Torque limit upper/motoring
- p1523 Torque limit, lower/regenerative
- p1524 Torque limit, upper/motoring, scaling
- p1525 Torque limit, lower/regenerating scaling
- p1530 Power limit, motoring
- p1531 Power limit, regenerating

The currently active torque limit values are displayed in the following parameters:

- r0067 Maximum drive output current
- r1526 Torque limit, upper/motoring without offset
- r1527 Torque limit, lower/regenerative without offset

All of the following limits act on the torque setpoint – that is either available at the speed controller output for closed-loop speed control or as torque input, for closed-loop torque control. The minimum or the maximum is used for the various limits. This minimum or maximum is cyclically calculated and is displayed in r1538 or r1539.

- r1538 Upper effective torque limit
- r1539 Lower effective torque limit

These cyclical values therefore limit the torque setpoint at the speed controller output/torque input or indicate the instantaneous max. possible torque. If the torque setpoint is limited, then this is displayed using parameter p1407.

- r1407.8 Upper torque limit active
- r1407.9 Lower torque limit active

Function diagram

FP 6060	Torque setpoint
FP 6630	Upper/lower torque limit
FP 6640	Current/power/torque limits

7.4.6 Permanent-magnet synchronous motors

Description

Permanent-magnet synchronous motors without encoders are supported during operations without encoders. Controlled operations are not possible when stationary.

Typical applications include direct drives with torque motors which are characterized by high torque at low speeds, e.g. Siemens complete torque motors of the 1FW3 series. When using these drives, gear units and therefore mechanical parts subject to wear can be dispensed with in such applications.

⚠WARNING

A soon as the motor starts to run, a voltage is produced. When working on the converter, the motor must be safely disconnected. If this cannot be done, the motor must be locked e.g. by a holding brake.

Features

- Field weakening of up to approx. 1.2 x rated speed (depending on the supply voltage of the converter and motor data, also see supplementary conditions)
- Capture (only when using a VSM module to record the motor speed and phase angle (option K51))
- Speed and torque control vector
- V/f control for diagnostics vector
- Motor identification
- Speed controller optimization (rotary measurement)

Limitations/secondary conditions

- Maximum speed or maximum torque depend on the converter output voltage available and the motor's back-EMF (calculation specifications: EMF must not exceed $U_{rated, converter}$).
- Calculating the maximum speed:
  $$n_{max} = V_{nom,AC} \times \frac{\sqrt{3} \times 30}{k_T \times \pi}$$
  Calculating kT: see "Commissioning"
- Depending on terminal voltage and load cycle, the maximum torque can be taken from the motor data sheets / project design instructions.
- There is no thermal model for the closed-loop control of a permanent-magnet synchronous motor. The motor can only be protected against overheating using a temperature sensor (PTC). We recommend that the motor temperature is measured using a temperature sensor (KTY) in order to achieve a high torque accuracy.

Commissioning

The following order is recommended for commissioning:

- Configure the drive

  While commissioning the drive using STARTER or AOP30 operator panel, the permanent-magnet synchronous motor must be selected. The motor data specified in the table below must then be entered. Finally, the motor identification routine and the speed optimization (p1900) are activated. The encoder adjustment is automatically activated together with the motor identification routine.
- Motor identification (standstill measurement, p1910)
- Speed controller optimization (rotary measurement, p1960)

Motor data for permanent-magnet synchronous motors

Table 7-2 Motor data type plate

Parameters	Description	Comments
p0304	Rated motor voltage	If this value is not known, then a value of "0" can also be entered. Entering the correct value, however, means that the stator leakage inductance (p0356, p0357) can be calculated more accurately.
p0305	Rated motor current	
p0307	Rated motor power	
p0310	Rated motor frequency	
p0311	Rated motor speed	
p0314	Motor pole pair number	If this value is not known, then a value of "0" can also be entered.
p0316	Motor torque constant	If this value is not known, the value "0" can also be entered.

If the details of the torque constant k_T are not provided on the type plate or in the data sheet, you can calculate them as follows from the rated motor data or from the zero-speed current I_0 and zero-speed torque M0:

$$k_T = \frac{M_N}{I_N} = \frac{60\frac{s}{min} \times P_N}{2\pi \times n_N \times I_N} \quad \text{or} \quad k_T = \frac{M_0}{I_0}$$

The optional motor data can be entered if you know them. Otherwise, these are estimated from the type plate data or established through motor identification or speed controller optimization.

Table 7-3 Motor data type plate

Parameters	Description	Comments
p0320	Rated motor short-circuit current	This is used for the field weakening characteristic
p0322	Maximum motor speed	Maximum mechanical speed
p0323	Maximum motor current	De-magnetization protection
p0325	Rotor position identification current, 1st phase	-
p0327	Optional load angle	Optional otherwise leave at 90°
p0328	Reluctance torque constant	-
p0329	Rotor position identification current	-
p0341	Motor moment of inertia	For speed controller pre-control
p0344	Motor weight	-
p0350	Stator resistance, cold	-
p0356	Quadrature axis stator inductance Lq	-
p0357	In-line stator inductance Ld	-

Short-circuit protection

For a short-circuit that can occur in the drive converter or in the motor cable, the rotating machine would supply the short-circuit until it comes to a standstill. An output contactor can be used for protection. This should be located as close as possible to the motor. This is especially necessary if the motor can still be driven by the load when a fault develops. The contactor must be provided with a protective circuit against overvoltage on the motor side so that the motor winding is not damaged as a result of the shutdown.

Control signal r0863.1 is used to control the contactor via a freely available digital output; the feedback signal contact of the contactor is connected to parameter p0864 via a free digital input.

This means that if the drive converter develops a fault with a shutdown response, at the instant in time that the pulses are inhibited, the motor is isolated from the drive converter so that energy is not fed back to the fault location.

Function diagram

FP 6721	Current control - Id setpoint (PEM, p0300 = 2)
FP 6724	Current control – field weakening controller (PEM, p0300 = 2)
FP 6731	Current control - interface to motor module (PEM, p0300 = 2)

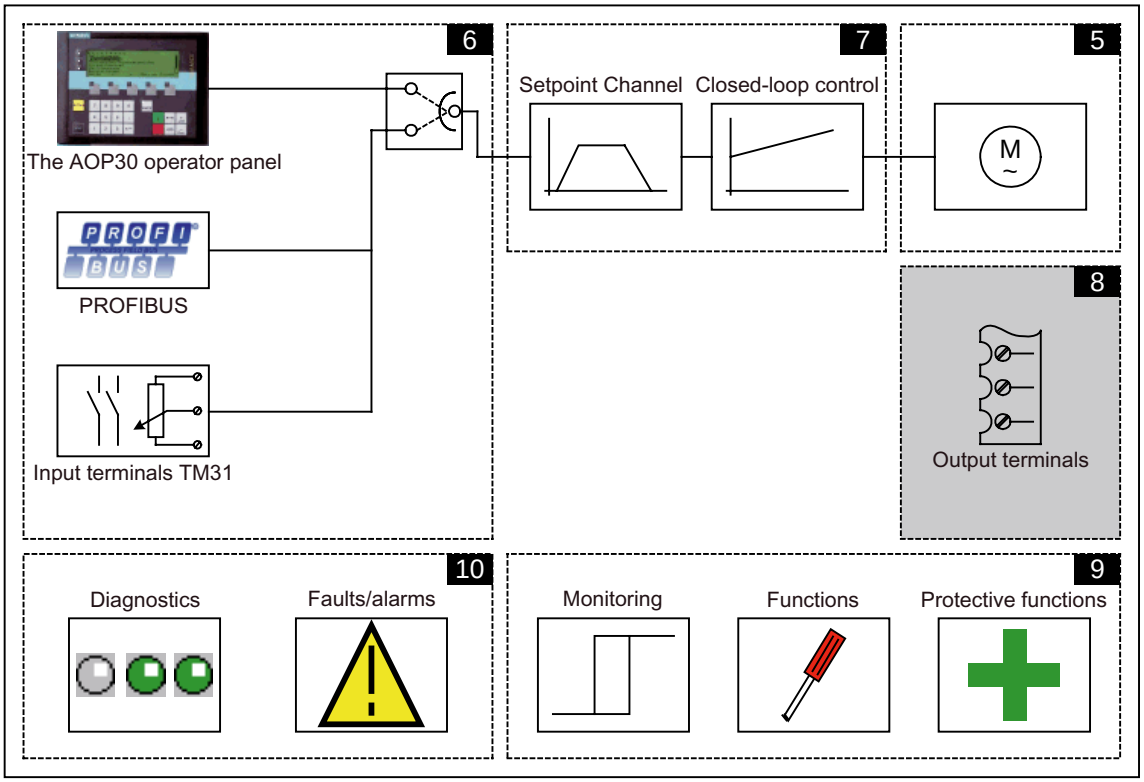
Output terminals

8

8.1 Chapter content

This chapter provides information on:

- Analog outputs
- Digital outputs



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (8xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD in the "SINAMICS G List Manual", which provides experienced users with detailed descriptions of all the functions.

8.2 TM31 analog outputs

Description

The TM31 terminal block module features two analog outputs for outputting setpoints via current or voltage signals.

Factory setting:

- AO0: Actual speed value: 0 – 10 V
- AO1: Actual motor current: 0 – 10 V

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" or "PROFIdrive+TM31" default setting was chosen during commissioning:

STARTER:	"TM31 terminals" or "PROFIdrive+TM31"
AOP30:	"2: TM31 terminals" or "4: PROFIdrive+TM31"

Signal flow diagram

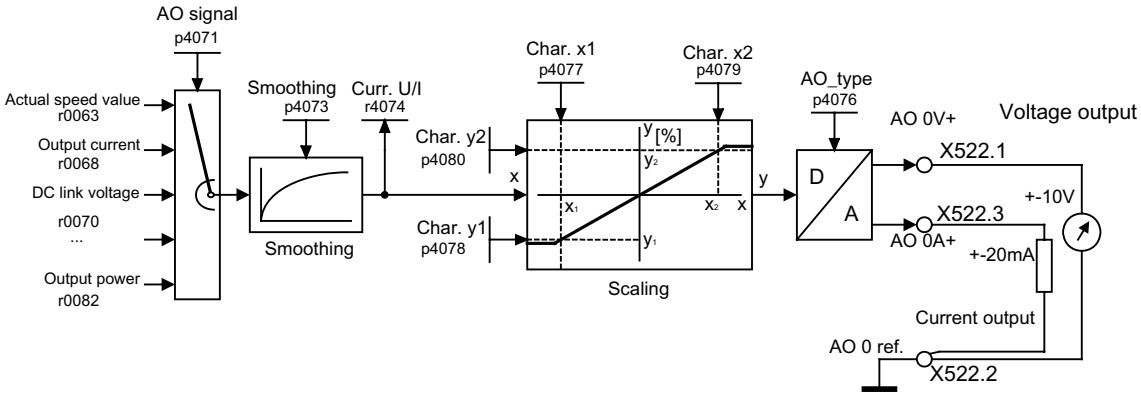


Figure 8-1 Signal flow diagram: analog output 0

Function diagram

FD 1840, FD 9572	TM31 - analog outputs (AO 0 ... AO 1)

Parameters

- p4071 Analog outputs, signal source
- p4073 Analog outputs, smoothing time constant
- r4074 Analog outputs, actual output voltage/current
- p4076 Analog outputs, type
- p4077 Analog outputs, characteristic value x1
- p4078 Analog outputs, characteristic value y1
- p4079 Analog outputs, characteristic value x2
- p4080 Analog outputs, characteristic value y2

8.2.1 List of signals for the analog signals

List of signals for the analog outputs

Table 8-1 List of signals for the analog outputs

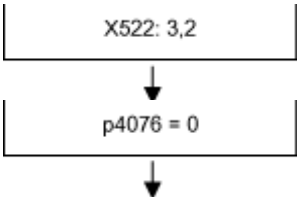
Signal	Parameters	Unit	Scaling (100 %=...) See table below
Speed setpoint before the setpoint filter	r0060	rpm	p2000
Motor speed unsmoothed	r0061	rpm	p2000
Actual speed smoothed	r0063	rpm	p2000
Output frequency	r0066	Hz	Reference frequency
Output current	r0068	Aeff	p2002
DC link voltage	r0070	V	p2001
Torque setpoint	r0079	Nm	p2003
Output power	r0082	kW	r2004
For diagnostic purposes			
Control deviation	r0064	rpm	p2000
Modulation depth	r0074	%	Reference modulation depth
Torque-generating current setpoint	r0077	A	p2002
Torque-generating actual current	r0078	A	p2002
Flux setpoint	r0083	%	Reference flux
Actual flux	r0084	%	Reference flux
For further diagnostic purposes			
Speed controller output	r1480	Nm	p2003
I component of speed controller	r1482	Nm	p2003

Scaling

Table 8-2 Scaling

Size	Scaling parameter	Default for quick commissioning
Reference speed	100 % = p2000	p2000 = Maximum speed (p1082)
Reference voltage	100 % = p2001	p2001 = 1000 V
Reference current	100 % = p2002	p2002 = Current limit (p0640)
Reference torque	100 % = p2003	p2003 = 2 x rated motor torque
Reference power	100 % = r2004	r2004 = (p2003 x p2000 x π) / 30
Reference frequency	100 % = p2000/60	
Reference modulation depth	100 % = Maximum output voltage without overload	
Reference flux	100 % = Rated motor flux	
Reference temperature	100% = 100°C	

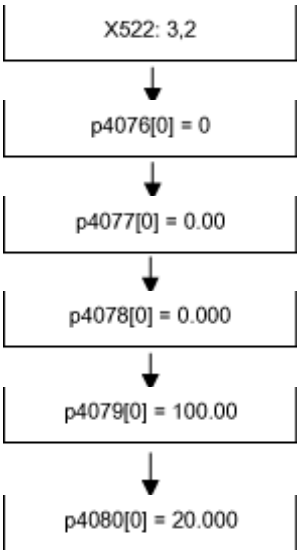
Example: changing analog output 0 from voltage to current output 0 ... 20 mA



Current output present at terminal 3, ground is at terminal 2

Set analog output type 0 to 0 ... 20 mA.

Example: changing analog output 0 from voltage to current output 0 ... 20 mA and setting the characteristic



Current output present at terminal 3, ground is at terminal 2

Set TM31.AO_type [analog output 0] to 0 ... 20 mA.

Set TM31.AO_char. x1 to 0.00%.

Set TM31.AO_char. y1 to 0 mA.

Set TM31.AO_char. x2 to 100.00%.

Set TM31.AO_char. y2 to 20 mA.

8.3 TM31 digital outputs

Description

Four bi-directional digital outputs (terminal X541) and two relay outputs (terminal X542) are available on the optional TM31 terminal block module. These outputs are, for the most part, freely parameterizable.

Prerequisites

- The Power Module, CU320, and TM31 have been correctly installed.
- The "TM31 terminals" or "Profidrive+TM31" default setting was chosen during commissioning:

STARTER:	"TM31 terminals" or "Profidrive+TM31"
AOP30:	"2: TM31 terminals" or "4: Profidrive+TM31"

Signal flow diagram

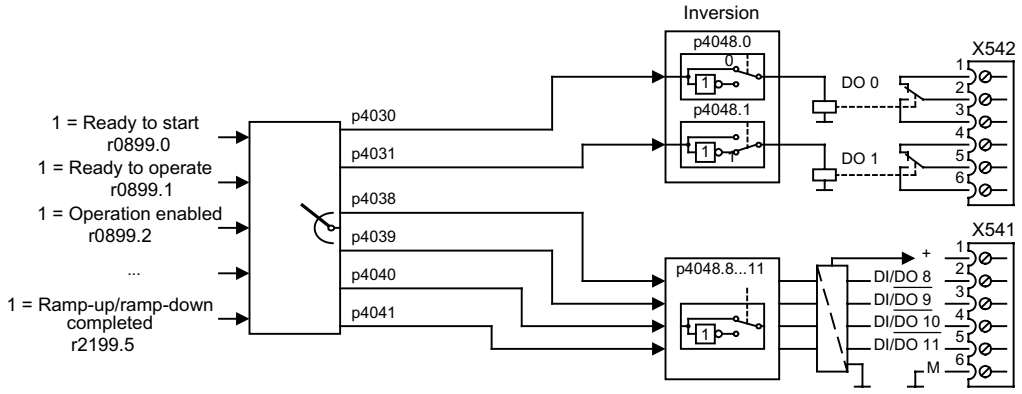


Figure 8-2 Signal flow diagram: Digital outputs

Factory settings

Table 8-3 Factory settings for digital outputs

Digital output	Terminal	Factory setting
DO0	X542: 2,3	"Enable pulses"
DO1	X542: 5,6	"No fault"
DI/DO8	X541: 2	"Ready to start"
DI/DO9	X541: 3	
DI/DO10	X541:4	
DI/DO11	X541: 5	

Selection of possible connections for the digital outputs

Table 8-4 Selection of possible connections for the digital outputs

Signal	Bit in status word 1	Parameter
1 = Ready to start	0	r0889.0
1 = Ready to operate (DC link loaded, pulses blocked)	1	r0889.1
1 = Operation enabled (drive follows n_set)	2	r0889.2
1 = Fault present	3	r2139.3
0 = Coast to stop active (OFF2)	4	r0889.4
0 = Fast stop active (OFF3)	5	r0889.5
1 = Power-on disable	6	r0889.6
1 = Alarm present	7	r2139.7
1 = Speed setpoint/actual deviation in the tolerance bandwidth (p2163, p2166)	8	r2197.7
1 = Control required to PLC	9	r0899.9
1 = f or n comparison value reached or exceeded (p2141, p2142)	10	r2199.1
1 = I, M, or P limit reached (p0640, p1520, p1521)	11	r1407.7
Reserved	12	
0 = Alarm motor overtemperature (A7910)	13	r2129.14
Reserved	14	
0 = Alarm thermal overload in power unit (A5000)	15	r2129.15
1 = Pulses enabled (inverter is clocking, drive is carrying current)		r0899.11
1 = n_act ≤ p2155		r2197.1
1 = n_act > p2155		r2197.2
1 = Ramp-up/ramp-down completed		r2199.5
1 = n_act < p2161 (preferably as n_min or n=0 message)		r2199.0
1 = Torque setpoint < p2174		r2198.10
1 = LOCAL mode active (control via operator panel)		r0807.0
0 = Motor blocked		r2198.6

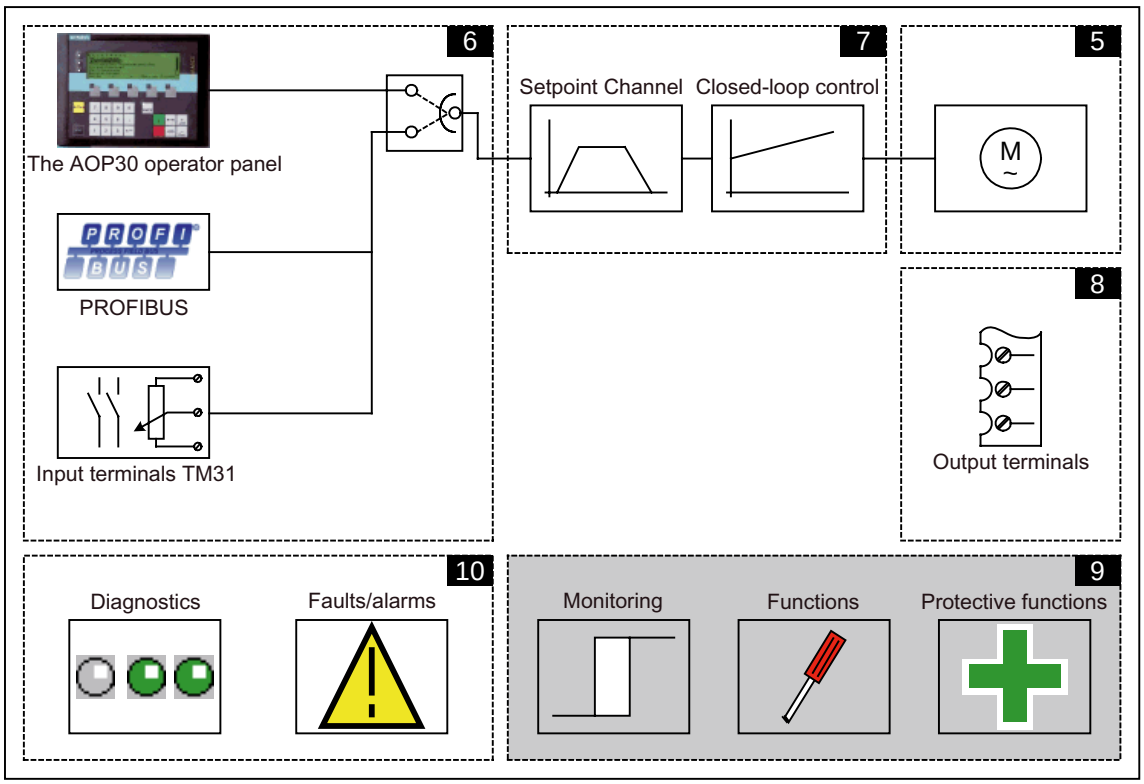
Functions, monitoring, and protective functions

9

9.1 Chapter content

This chapter provides information on:

- Drive functions:
  Motor identification, Vdc control, automatic restart, flying restart, motor changeover, friction characteristic, increase in the output frequency, runtime, simulation operation, direction reversal, unit changeover
- Extended functions:
  Technology controller, bypass function, extended brake control, extended monitoring functions
- Monitoring and protective functions:
  Power unit protection, thermal monitoring functions and overload responses, blocking protection, stall protection, thermal motor protection.



Function diagrams

To supplement these operating instructions, the CD contains simplified function diagrams describing the operating principle.
The diagrams are arranged in accordance with the chapters in the operating instructions. The page numbers (9xx) describe the functionality in the following chapter.

At certain points in this chapter, reference is made to function diagrams with a 4-digit number. These are stored on the CD in the "SINAMICS G List Manual", which provides experienced users with detailed descriptions of all the functions.

9.2 Drive functions

9.2.1 Motor identification and automatic speed controller optimization

Description

Two motor identification options, which are based on each other, are available:

- Standstill measurement with p1910 (motor identification)
- Rotating measurement with p1960 (speed controller optimization)

These can be selected more easily via p1900. p1900 = 2 selects the standstill measurement (motor not rotating). p1900 = 1 also activates the rotating measurement; p1900 = 1 sets p1910 = 1 and p1960 in accordance with the current control type (p1300).

Parameter p1960 is set depending on p1300:

- p1960 = 1, if p1300 = 20 or 22 (encoderless control)
- p1960 = 2, if p1300 = 21 or 23 (control with encoder)

The measurements parameterized using p1900 are started in the following sequence after the corresponding drive has been enabled:

- Standstill (static) measurement - after the measurement has been completed, the pulses are inhibited and parameter p1910 is reset to 0.
- Encoder adjustment - after the measurement has been completed, the pulses are inhibited and parameter p1990 is reset to 0.
- Rotating measurement - after the measurement has been completed, the pulses are inhibited and parameter p1960 is reset to 0.
- After all of the measurements activated using p1900 have been successfully completed, p1900 itself is set to 0.

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non-volatile CompactFlash card.

⚠ DANGER

During motor identification, the drive might set the motor in motion.

The EMERGENCY STOP functions must be fully operational during commissioning. To protect the machines and personnel, the relevant safety regulations must be observed.

9.2.1.1 Standstill measurement

Description

Motor identification with p1910 is used for determining the motor parameters at standstill (see also p1960: speed controller optimization):

- Equivalent circuit diagram data p1910 = 1
- Magnetization characteristic p1910 = 3

For control engineering reasons, you are strongly advised to carry out motor identification because the equivalent circuit diagram data, motor cable resistance, IGBT on-state voltage, and compensation for the IGBT lockout time can only be estimated if the data on the type plate is used. For this reason, the stator resistance for the stability of sensorless vector control or for the voltage boost with the V/f characteristic is very important.

Motor identification is essential if long supply cables or third-party motors are used. When motor data identification is started for the first time, the following data is determined with p1910 = 1 on the basis of the data on the type plate (rated data):

- Equivalent circuit diagram data
- Total resistance of:
  - Power cable resistance (R_{cable}) and
  - Stator resistance (R_S)
- IGBT on-state voltage/compensation for the IGBT lockout time

Since the type plate data provides the initialization values for identification, you must ensure that it is entered correctly and consistently (taking into account the connection type (star/delta)) so that the above data can be determined.

If the resistance of the motor supply cable is known, you are advised to enter this value before the standstill measurement (p0352) so that it can be subtracted from the total measured resistance when the stator resistance (p0350) is calculated.

Entering the cable resistance improves the accuracy of thermal resistance adaptation, particularly when long supply cables are used. This governs behavior at low speeds, particularly during encoderless vector control.

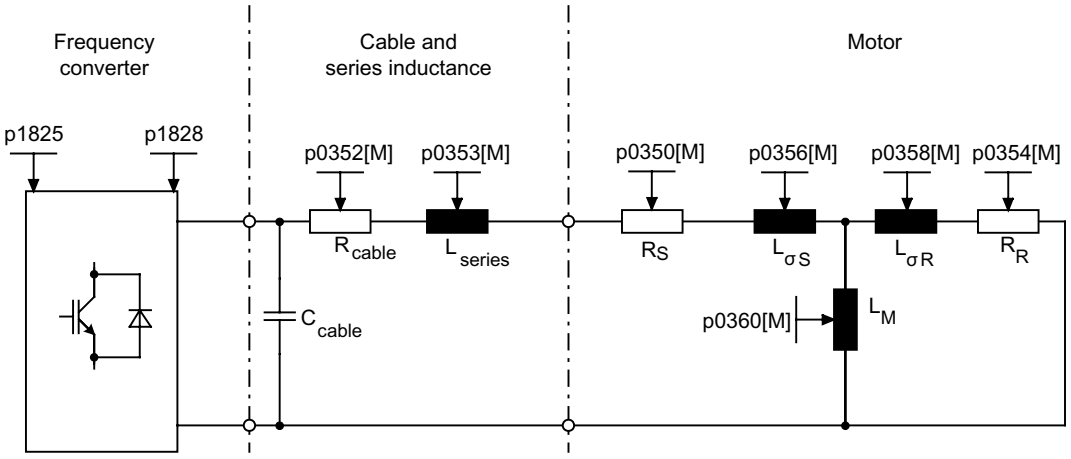


Figure 9-1 Equivalent circuit diagram for induction motor and cable

If an output filter (see p0230) or series inductance (p0353) is used, its data must also be entered before the standstill measurement is carried out.

The inductance value is then subtracted from the total measured value of the leakage. With sine-wave filters, only the stator resistance, valve threshold voltage, and valve interlocking time are measured.

Note

Leakage values in excess of 35 to 40% of the rated motor impedance will restrict the dynamic response of speed and current control in the voltage limit range and in field-weakening operation.

Note

Standstill measurement must be carried out when the motor is cold. In p0625, enter the estimated ambient temperature of the motor during the measurement (with KTY sensor: set p0600, p0601 and read r0035). This is the reference point for the thermal motor model and thermal R_S/R_R adaptation.

In addition to the equivalent circuit diagram data, motor data identification (p1910 = 3) can be used for induction motors to determine the magnetization characteristic of the motor. Due to the higher accuracy, the magnetization characteristic should, if possible, be determined during rotating measurement (without encoder: p1960 = 1, 3; with encoder: p1960 = 2, 4). If the drive is operated in the field-weakening range, this characteristic should be determined for vector control in particular. The magnetization characteristic can be used to calculate the field-generating current in the field-weakening range more accurately, thereby increasing torque accuracy.

Note

In comparison with standstill measurement (p1910) for induction motors, rotating measurement (p1960) allows the rated magnetization current and saturation characteristic to be determined more accurately.

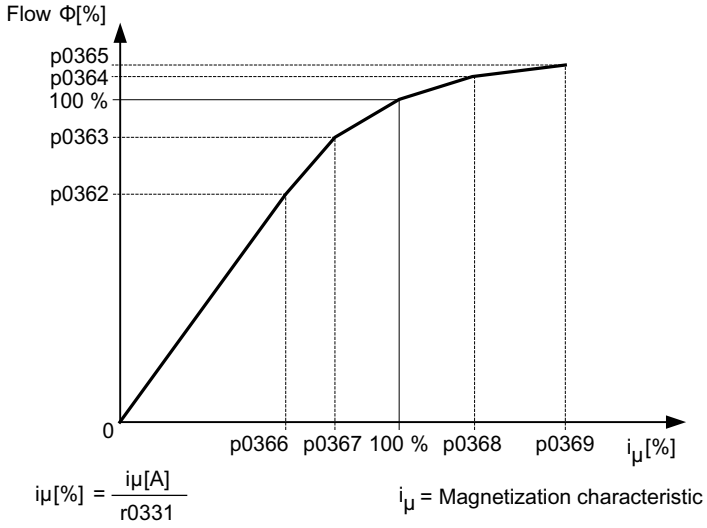


Figure 9-2 Magnetization characteristic

Carrying out motor identification

- Enter p1910 > 0. Alarm A07991 is displayed.
- Identification starts when the motor is switched on.
- p1910 resets itself to "0" (successful identification) or fault F07990 is output.
- r0047 displays the current status of the measurement.

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 on the non-volatile CompactFlash card.

⚠ WARNING

During motor identification, the drive might set the motor in motion.

The EMERGENCY STOP functions must be fully operational during commissioning. To protect machines and personnel, the relevant safety regulations must be observed.

The following parameters are determined by means of motor identification:

- p1910 = 1 and induction motor:
  p0350, p0354, p0356, p0358, p0360, p1825, p1828, p1829, p1830
- p1910 = 3 and induction motor:
  p0362 ... p0366
- p1910 = 1 and permanent-magnet synchronous motor:
  p0350, p0356, p0357, p1825, p1828, p1829, p1830

9.2.1.2 Rotating measurement and speed controller optimization

Description

"Rotating measurement" can be activated via p1960 or p1900 = 1.

The main difference affecting rotating measurement is speed controller optimization for determining the drive moment of inertia and setting of the speed controller. On induction motors, the saturation characteristic and rated magnetization current are also measured.

If rotating measurement is not to be carried out at the speed set in p1965, this parameter can be changed before the measurement is started. Higher speeds are recommended. The same applies to the speed in p1961, at which the saturation characteristic is determined and the encoder test is carried out.

The speed controller is set to the symmetrical optimum in accordance with dynamic factor p1967. p1967 must be set before the optimization run and only affects the calculation of the controller parameters.

If, during the measurement, it becomes clear that the the drive cannot operate in a stable manner with the specified dynamic factor or that the torque ripples are too great, the dynamic response is reduced automatically and the result displayed in r1968. The drive must also be checked to ensure that it is stable across the entire range. The dynamic response might need to be reduced or Kp/Tn adaptation for the speed controller parameterized accordingly.

When commissioning induction machines, you are advised to proceed as follows:

- Before connecting the load, a complete "rotating measurement" (without encoder: p1960 = 1; with encoder: p1960 = 2) should be carried out. Since the induction machine is idling, you can expect highly accurate results for the saturation characteristic and the rated magnetization current.
- When the load is connected, speed controller optimization should be repeated because the total moment of inertia has changed. This is realized by selecting parameter p1960 (without encoder: p1960 = 3; with encoder: p1960 = 4).

When permanent-magnet synchronous motors are commissioned, the speed controller should be optimized (p1960 = 2/4) when the load is connected.

Rotating measurement sequence (p1960 > 0)

The following measurements are carried out when the enable signals are set and a switch-on command is issued in accordance with the settings in p1959 and p1960.

- Encoder test
  If a speed controller is in use, the direction of rotation and pulse number per revolution are checked.
- Only for induction motors:
  - Measurement of the magnetization characteristic (p0362 to p0369)
  - Measurement of the magnetization current (p0320) and determination of the offset voltage of the converter for offset compensation
  - Measurement of the leakage inductance saturation and setting of the current controller adaptation (p0391…p0393)
    This is activated automatically on 1LA1 and 1LA8 motors (p0300 = 11, 18) (see p1959.5).

- Speed controller optimization
  - p1470 and p1472, if p1960 = 1 (encoderless operation)
  - p1460 and p1462, if p1960 = 2 (operation with encoder)
  - Kp adaptation switch-off
- Acceleration pre-control setting (p1496)
- Setting for ratio between the total moment of inertia and that of the motor (p0342)

Note

To set the new controller setting permanently, the data must be saved with p0977 or p0971 to non-volatile memory on the CompactFlash card.

⚠DANGER

During speed controller optimization, the drive triggers movements in the motor that can reach the maximum motor speed.

The EMERGENCY STOP functions must be fully operational during commissioning. To protect machines and personnel, the relevant safety regulations must be observed.

Note

If speed controller optimization is carried out for operation with an encoder, the control mode will be changed over to encoderless speed control automatically, in order to be able to carry out the encoder test.

Parameters

- r0047 Status identification
- p1300 Open-loop/closed-loop control operating mode
- p1900 Motor data identification and rotating measurement
- p1959 Speed controller optimization configuration
- p1960 Speed controller optimization selection
- p1961 Saturation characteristic speed for calculation
- p1965 Speed controller optimization speed
- p1967 Speed controller optimization dynamic factor
- r1969 Speed controller optimization inertia identified
- r3925 Identification complete indicator
- r3927 MotId control word
- r3928 Rotating measurement configuration

9.2.2 Efficiency optimization

Description

The following can be achieved when optimizing efficiency using p1580:

- Lower motor losses in the partial load range
- Minimization of noise in the motor

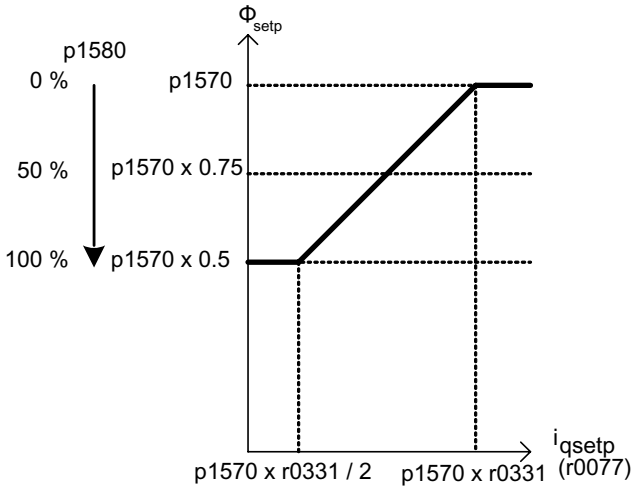


Figure 9-3 Efficiency optimization

It only makes sense to activate this function if the dynamic response requirements of the speed controller are low (e.g., pump and fan applications).

For p1580 = 100%, the flux in the motor under no-load operating conditions is reduced to half of the setpoint (reference flux) (p1570/2). As soon as load is connected to the drive, the setpoint (reference) flux increases linearly with the load and, reaching the setpoint set in p1570 at approx. r0077 = r0331 x p1570.

In the field-weakening range, the final value is reduced by the actual degree of field weakening. The smoothing time (p1582) should be set to approx. 100 to 200 ms. Flux differentiation (see also p1401.1) is automatically deactivated internally following magnetization.

Function diagram

FP 6722	Field weakening characteristic, Id setpoint (ASM, p0300 = 1)
FP 6723	Field weakening control, flux control for induction motor (p0300 = 1)

Parameters

- r0077 Current setpoints, torque-generating
- r0331 Motor magnetizing current/short-circuit current (actual)
- p1570 Flux setpoint
- p1580 Efficiency optimization

9.2.3 Vdc control

Description

The “Vdc control” function can be activated using the appropriate measures if an overvoltage or undervoltage is present in the DC link.

- Overvoltage in the DC link
  - Typical cause:
    The drive is operating in regenerative mode and is supplying too much energy to the DC link.
  - Remedy:
    Reduce the regenerative torque to maintain the DC link voltage within permissible limits.

  Note

  When switching off or during rapid load changes, if failure often arises and fault F30002 "DC link overvoltage" is reported, you may be able to improve the situation by increasing the gain factor for the Vdc controller p1250 (p1290), e.g. from "1.00" to "2.00".

- Undervoltage in the DC link
  - Typical cause:
    Failure of the supply voltage or supply for the DC link.
  - Remedy:
    Specify a regenerative torque for the rotating drive to compensate the existing losses, thereby stabilizing the voltage in the DC link This process is known as kinetic buffering.
    Kinetic buffering is only possible as long as energy is generated by the movement of the drive.

Characteristics

- Vdc control
  - This comprises Vdc_max control and Vdc_min control (kinetic buffering), which are independent of each other.
  - It contains a joint PI controller. The dynamic factor is used to set Vdc_min and Vdc_max control independently of each other.
- Vdc_min control (kinetic buffering)
  - With this function, the kinetic energy of the motor is used for buffering the DC link voltage in the event of a momentary power failure, thereby delaying the drive.
- Vdc_max-Regelung
  - This function can be used to control a momentary regenerative load without shutdown with "overvoltage in DC link".
  - Vdc_max control is only recommended for a supply without active closed-loop control for the DC link and without feedback.

Description of Vdc_min control (kinetic buffering)

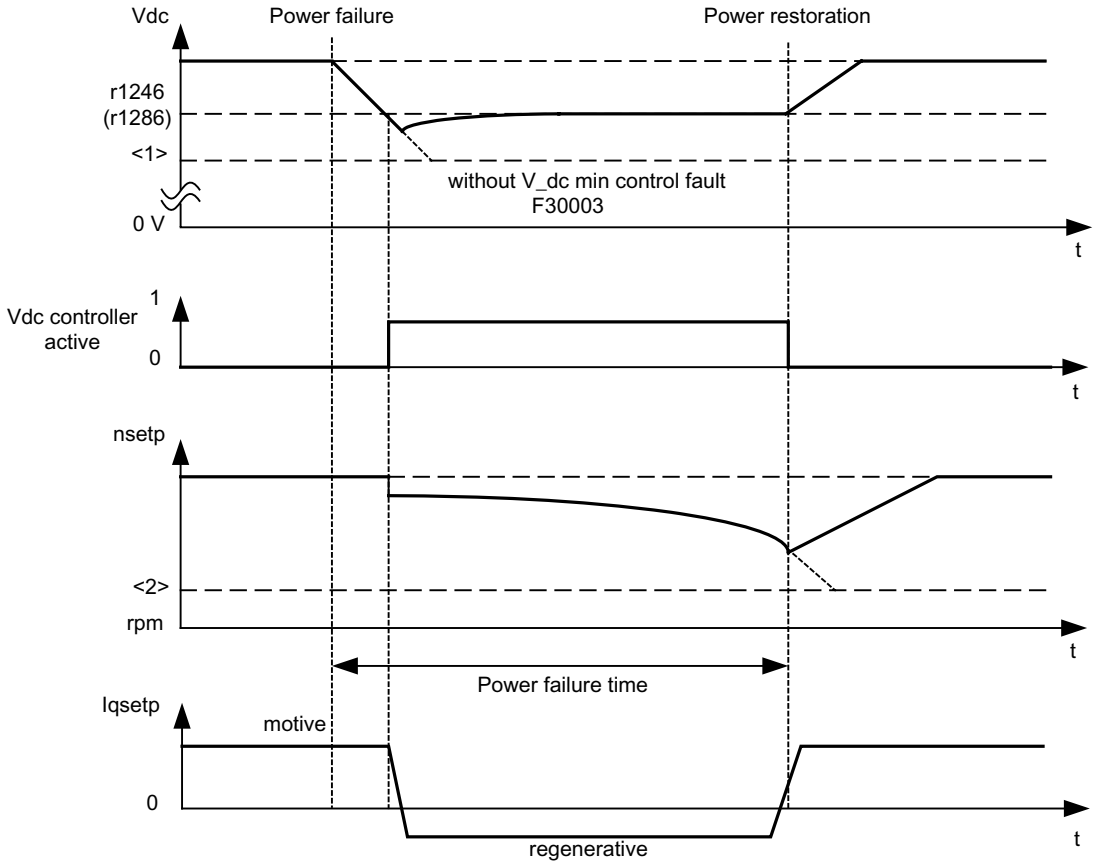


Figure 9-4 Switching Vdc_min control on/off (kinetic buffering)

Note

Kinetic buffering must only be activated when the optional components (TM31, SMC30, VSM, etc.) are supplied by an external voltage source.

When Vdc_min control is enabled with p1240 = 2.3 (p1280), it is activated if the power fails when the Vdc_min switch-in level (r1246 (r1286)) is undershot. In general, the regenerative power (braking energy) of the drive machine generated when the motor speed is reduced is used to buffer the DC link voltage of the converter; in other words, when Vdc_min control is active, the motor speed no longer follows the main setpoint and can be reduced to zero. The SINAMICS system continues operating until the shutdown threshold of the DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>).

Note

All parameter specifications in parentheses refer to V/f control.

- V/f control
  The Vdc_min controller acts on the speed setpoint channel. When Vdc_min control is active, the drive setpoint speed is reduced so that the drive becomes regenerative.
- Speed control
  The Vdc_min controller acts on the speed controller output and affects the torque-generating current setpoint. When Vdc_min control is active, the torque-generating current setpoint is reduced so that the drive becomes regenerative.

If the power fails, the DC link voltage decreases due to the lack of power from the supply system. When the DC link voltage threshold set via parameter p1245 (p1285) is reached, the Vdc_min controller is activated. Due to the PID properties of the controller, the motor speed is reduced to the extent that the regenerative drive energy maintains the DC link voltage at the level set in p1245 (p1285). The kinetic energy of the drive governs the dropout characteristic of the motor speed and, in turn, the buffering duration. In centrifugal mass drives (e.g. fans), buffering can last a few seconds. In drives with a low centrifugal mass (e.g. pumps), however, buffering can last just 100 – 200 ms. When the power is restored, the Vdc_min controller is deactivated and the drive is ramped up to its setpoint speed at the ramp-function generator ramp. Alarm A7402 (drive: DC link voltage minimum controller active) is issued while the Vdc_min controller is active.

If the drive can no longer generate any regenerative energy (because, for example, it is almost at a standstill), the DC link voltage continues to drop. If the minimum DC link voltage is undershot (see "Switching Vdc_min control on/off" <1>), the drive is switched off with fault F30003 (power unit: DC link undervoltage).

If a speed threshold set with parameter p1257 (p1297) for active Vdc_min control (see "Switching Vdc_min control on/off" <2>) is undershot, the drive is shut down with F7405 (drive: kinetic buffering minimum speed undershot).

If a shutdown with undervoltage in the DC link (F30003) occurs without the drive coming to a standstill despite the fact that Vdc_min control is active, the controller may have to be optimized via dynamic factor p1247 (p1287). Increasing the dynamic factor in p1247 (p1287) causes the controller to intervene more quickly. The default setting for this parameter, however, should be sufficient for most applications.

Parameter p1256 = 1 (p1296) can be used to activate time monitoring for kinetic buffering. The monitoring time can be set in parameter p1255 (p1295). If buffering (i.e. the power failure) lasts longer than the time set here, the drive is switched off with fault F7406 (drive: kinetic buffering maximum time exceeded). The standard fault reaction for this fault is OFF3, which means that this function can be used for controlled drive deceleration in the event of a power failure. In this case, excess regenerative energy can only be dissipated via an additional braking resistor.

Description of Vdc_max control

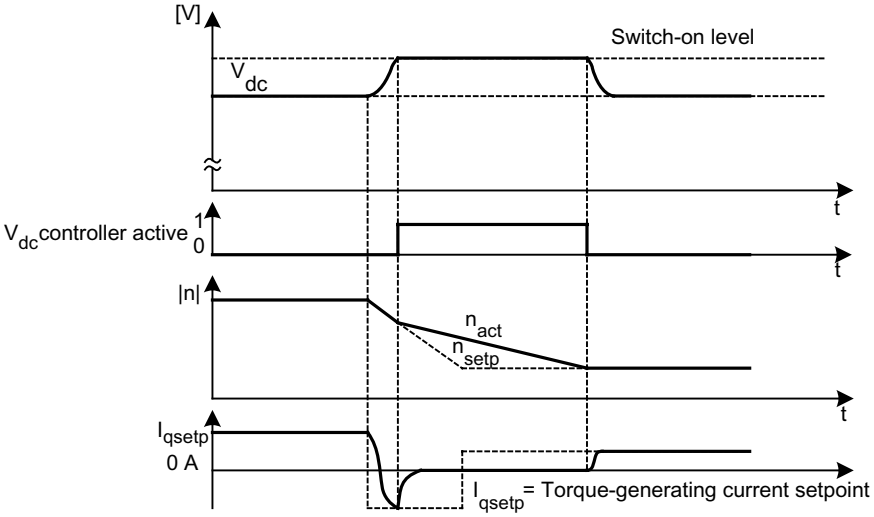


Figure 9-5 Activating/deactivating the Vdc_max control

The switch-on level of the Vdc_max control (r1242 or r1282) is calculated as follows:

- when the automatic switch-in level sensing is disabled (p1254 = 0)
  r1242 (r1282) = 1.15 x p0210 (device supply voltage, DC link)
- when the automatic switch-on level sensing is enabled (p1254 = 1)
  r1242 (r1282) = Vdc_max - 50 V (Vdc_max: overvoltage threshold of the converter)

Function diagram

FD 6220 (FP 6320)	Vdc_max controller and Vdc_min controller

Parameters

- p1240 (p1280) Vdc controller configuration
- r1242 (r1282) Vdc_min controller switch-in level
- p1243 (p1283) Vdc_max controller dynamic factor
- p1245 (p1285) Vdc_min controller switch-in level
- p1246 (p1286) Vdc_min controller switch-in level
- p1247 (p1287) Vdc_min controller dynamic factor
- p1250 (p1290) Vdc controller proportional gain
- p1251 (p1291) Vdc controller integral action time
- p1252 (p1292) Vdc controller derivative-action time
- (p1293) Vdc_min controller output limit (V/f control)
- p1254 (p1294) Vdc_max controller automatic ON level detection
- p1255 (p1295) Vdc_min controller time threshold
- p1256 (p1296) Vdc_min controller response
- p1257 (p1297) Vdc_min controller speed threshold
- r1258 (r1298) Vdc controller output

9.2.4 Automatic restart function

Description

The automatic restart function automatically restarts the cabinet unit after an undervoltage or a power failure. The alarms present are acknowledged and the drive is restarted automatically.

The drive can be restarted using:

- The standard procedure starting from standstill, or
- The flying restart function.
  For drives with low moments of inertia and load torques facilitating the stopping of the drive within a matter of seconds (e.g., pump drives with water gauges), starting from standstill is recommended.

Note

The flying restart function can also be activated for drives with large moments of inertia (such as fan drives). This enables you to switch to the motor that is still rotating.

⚠ WARNING

If p1210 is set to values >1, the motor can be restarted automatically without the need to issue the ON command.

In the event of prolonged power failures and when the automatic restart function is activated (p1210 > 1), the drive may have been at a standstill for a long time and mistakenly considered to have been switched off.

For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

Automatic restart mode

Table 9-1 Automatic restart mode

p1210	Mode	Meaning
0	Disables automatic restart	Automatic restart inactive
1	Acknowledges all faults without restarting	If p1210 = 1, pending faults will be acknowledged automatically once their cause has been rectified. If further faults occur after faults have been acknowledged, these will also be acknowledged automatically. A minimum time of p1212 + 1s must elapse between successful fault acknowledgement and a fault reoccurring if the ON/OFF1 signal (control word 1, bit 0) is at HIGH. If the ON/OFF1 signal is at LOW, the time between successful fault acknowledgement and a new fault must be at least 1s. If p1210 = 1, fault F07320 will not be generated if the acknowledge attempt fails (e.g., because the faults occurred too frequently).
4	Automatic restart after line supply failure, no additional startup attempts	If p1210 = 4, an automatic restart will only be performed if in addition fault F30003 occurs on the Motor Module or there is a high signal at binector input p1208[1], or in the case of an infeed drive object (A_Infeed), F06200 is pending. If additional faults are pending, then these faults will also be acknowledged; if this is successful, the startup attempt will be resumed. The failure of the CU's 24 V power supply will be interpreted as a line supply failure.
6	Restart after any fault with additional startup attempts	If p1210 = 6, an automatic restart will be performed after any fault or at p1208[0] = 1. If the faults occur one after the other, then the number of startup attempts is defined using p1211. Monitoring over time can be set using p1213.

Startup attempts (p1211) and waiting time (p1212)

p1211 is used to specify the number of startup attempts. The number is decremented internally after each successful fault acknowledgement (line supply voltage must be restored or the infeed signals that it is ready). Fault F07320 is output when the number of parameterized startup attempts is reached.

If p1211 = x, x + 1 startup attempts will be made.

Note

A startup attempt starts immediately when the fault occurs.

The faults are acknowledged automatically at intervals of half the waiting time p1212.

Following successful acknowledgement and restoration of the voltage, the system is automatically powered up again.

The startup attempt has been completed successfully once the flying restart and magnetization of the motor (induction motor) has been completed (r0056.4 = 1) and one additional second has expired. The startup counter is not reset to the initial value p1211 until this point.

If additional faults occur between successful acknowledgement and the end of the startup attempt, then the startup counter, when it is acknowledged, is also decremented.

Monitoring time power restoration (p1213)

The monitoring time starts when the faults are detected. If the automatic acknowledgements are not successful, the monitoring time will continue. If the drive has not successfully restarted by the time the monitoring time expires (flying restart and motor magnetization must have been completed: r0056.4 = 1), fault F07320 is output. Monitoring is deactivated by setting p1213 = 0.

If p1213 is set to a value lower than the sum of p1212, the magnetization time r0346 and the additional delay time due to flying restart, then fault F07320 will be generated on every restart attempt. If, for p1210 = 1, the time in p1213 is set to a value lower than p1212, then fault F07320 will also be generated on every restart attempt. The monitoring time must be extended if the faults that occur cannot be immediately and successfully acknowledged (e.g., when faults are permanently present).

Parameters

- p1210 Automatic restart mode
- p1211 Automatic restart, start attempts
- p1212 Automatic restart, delay time start attempts
- p1213 Automatic restart, monitoring line supply return

Settings

To prevent the motor from switching to phase opposition when the drive is being restarted, there is a delay while the motor demagnetizes (t = 2.3 x motor magnetization time constant). Once this time has elapsed, the inverter is enabled and the motor is supplied with power.

9.2.5 Flying restart

Description

The "Flying restart" function (enabled via p1200) allows the converter to switch to a motor that is still rotating. Switching on the converter without the flying restart function would not allow any flux to build up in the motor while it is rotating. Since the motor cannot generate any torque without flux, this can cause it to switch off due to overcurrent (F07801).

The flying restart function first determines the speed of the drive with which V/f or vector control is initialized so that the converter and motor frequency can be synchronized.

During the standard start-up procedure for the converter, the motor must be at a standstill. The converter then accelerates the motor to the setpoint speed. In many cases, however, the motor is not at a standstill.

Two different situations are possible here:

1. The drive rotates as a result of external influences, such as water (pump drives) or air (fan drives). In this case, the drive can also rotate against the direction of rotation.
2. The drive rotates as a result of a previous shutdown (e.g. OFF 2 or a power failure). The drive slowly coasts to a standstill as a result of the kinetic energy stored in the drive train (example: induced-draft fan with a high moment of inertia and a steeply descending load characteristic in the lower speed range).

In accordance with the setting chosen (p1200), the flying restart function is activated in the following situations:

- Once power has been restored and the automatic restart function is active
- After a shutdown with the OFF2 command (pulse inhibit) when the automatic restart function is active
- When the ON command is issued.

Note

The flying restart function must be used when the motor may still be running or is being driven by the load to prevent shutdowns due to overcurrent (F7801).

Note

If the value set for parameter p1203 (search speed factor) is higher, the search curve is flatter and, as a result, the search time is longer. A lower value has the opposite effect.

In motors with a low moment of inertia, the flying restart function can cause the drive to accelerate slightly.

In group drives, the flying restart function should not be activated due to the different coasting properties of the individual motors.

9.2.5.1 Flying restart without encoder

Description

Depending on parameter p1200, the flying restart function is started with the maximum search speed $n_{search,max}$ once the de-excitation time (p0347) has elapsed (see diagram "Flying restart").

$n_{Search,max} = 1.25 \times n_{max}$ (p1082)

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
  The search speed yielded from parameter p1203 reduces the search frequency in accordance with the motor current. The parameterizable search current (p1202) is injected here. If the search frequency is similar to the rotor frequency, a current minimum occurs. Once the frequency has been found, the motor is magnetized. The output voltage during the magnetization time (p0346) is increased to the voltage value yielded from the V/f characteristic (see "Flying restart").
- Vector control without encoder:
  The motor speed is determined using the speed adaptation control loop for the electric motor model. To begin with, the search current (p1202) is injected and then the controller is activated starting from the maximum search frequency. The dynamic response of the controller can be altered using the search speed factor (p1203). If the deviation of the speed adaptation controller is not too great, the motor continues to be magnetized for the duration parameterized in p0346.

Once the excitation build-up time (p0346) has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint frequency.

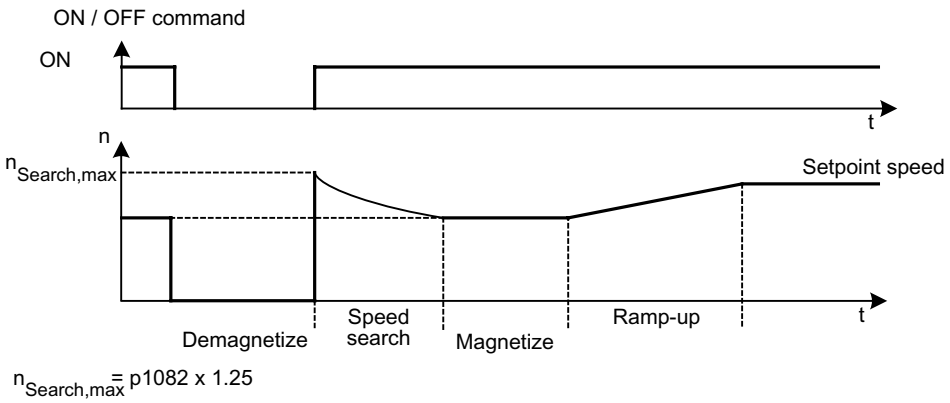


Figure 9-6 Flying restart

⚠ WARNING

When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0!

For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

9.2.5.2 Flying restart with encoder

Description

The flying restart function behaves differently with V/f control and vector control:

- V/f characteristic (p1300 < 20):
  Flying restart without encoder (see "Flying restart without encoder")
- Vector control with encoder:
  Since the speed is known from the start, the motor can be magnetized immediately at the appropriate frequency. The duration of magnetization is specified in p0346. Once the excitation build-up time has elapsed, the ramp-function generator is set to the actual speed value and the motor ramped up to the current setpoint speed.

⚠ WARNING

When the flying restart (p1200) function is active, the drive may still be accelerated by the detection current despite the fact that it is at standstill and the setpoint is 0.

For this reason, entering the area around the drive when it is in this condition can cause death, serious injury, or considerable material damage.

9.2.5.3 Parameters

- p1200 Flying restart operating mode
  - 0: Flying restart inactive
  - 1: Flying restart is always active (start in the setpoint direction).
  - 2: Flying restart is active after: power-on, fault, OFF2 (start in the setpoint direction).
  - 3: Flying restart is active after: fault, OFF2. (start in the setpoint direction).
  - 4: Flying restart is always active (start only in the setpoint direction).
  - 5: Flying restart is active after: power-on, fault, OFF2 (start only in the setpoint direction).
  - 6: Flying restart is active after: fault, OFF2 (start only in the setpoint direction).
- p1202 Flying restart search current
- p1203 Flying restart search rate factor
- r1204 Flying restart, V/f control status
- r1205 Flying restart, vector control status

9.2.6 Motor changeover/selection

9.2.6.1 Description

The motor data set changeover is, for example, used for:

- Changing over between different motors
- Motor data adaptation

Note

To switch to a rotating motor, the "flying restart" function must be activated.

9.2.6.2 Example of changing over between two motors

Prerequisites

- The drive has been commissioned for the first time.
- 2 motor data sets (MDS), p0130 = 2
- 2 drive data sets (DDS), p0180 = 2
- 2 digital outputs to control the auxiliary contactors
- 2 digital inputs to monitor the auxiliary contactors
- 1 digital input to select the data set
- 2 auxiliary contactors with auxiliary switches (1 NO contact)
- 2 motor contactors with positively-driven auxiliary switches (1 NC contact, 1NO contact)

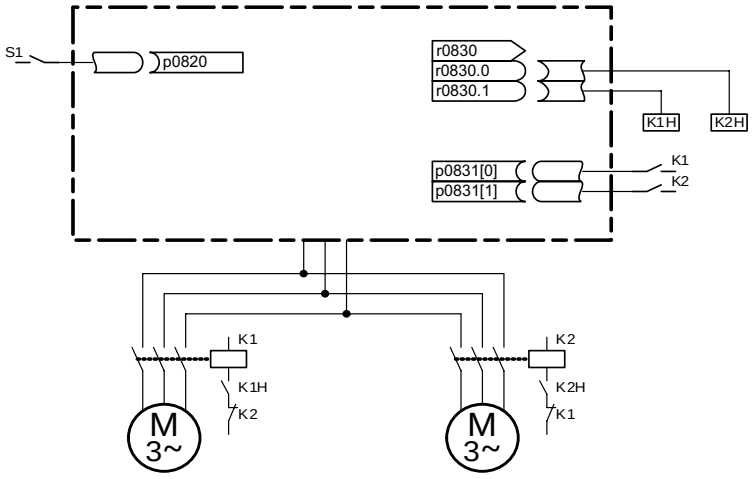


Figure 9-7 Example of motor changeover

Table 9-2 Settings for the motor changeover example

Parameters	Settings	Comments
p0130	2	Configure 2 MDS
p0180	2	Configure 2 DDS
p0186[0..1]	0, 1	The MDS are assigned to the DDS.
p0820	Digital input, DDS selection	The digital input to change over the motor is selected via the DDS. Binary coding is used (p0820 = bit 0, etc.).
p0821 to p0824	0	
p0826[0..1]	1, 2	Different numbers mean different thermal models.
p0827[0..1]	0, 1	The bits of p0830 are assigned to the MDS. If p0827[0] = 0, for example, bit p0830.0 is set via DDS0 when MDS0 is selected.
p0830.0 and p0830.1	Digital outputs, auxiliary contactors	The digital outputs for the auxiliary contactors are assigned to the bits.
p0831[0..1]	Digital inputs, auxiliary contacts	The digital inputs for the feedback signal of the motor contactors are assigned.
p0833.00 and .01	0, 0	The drive controls the contactor circuit and pulse suppression.

Motor changeover sequence

1. Pulse suppression:
   The pulses are suppressed following the selection of a new drive data set using p0820 to p0824.
2. Open motor contactor:
   Motor contactor 1 is opened r0830 = 0 and the status bit "Motor changeover active" (r0835.0) is set.
3. Change over drive data set:
   The requested data set is activated (r0051 = data set currently effective, r0837 = requested data set).
4. Energize motor contactor:
   After the feedback signal (motor contactor opened) from motor contactor 1, the appropriate bit of r0830 is set and motor contactor 2 is energized.
5. Enable pulses:
   After the feedback signal (motor contactor closed) from motor contactor 2, the bit "motor data set changeover active" (r0835.0) is reset and the pulses are enabled. The motor has now been changed over.

9.2.6.3 Function diagram

FP 8565 Drive Data Set (DDS)
FP 8575 Motor Data Sets (MDS)

9.2.6.4 Parameters

- r0051 Drive data set DDS effective
- p0130 Motor data sets (MDS) number
- p0180 Drive data set (DDS) number
- p0186 Motor data sets (MDS) number
- p0819[0...2] Copy drive data set DDS
- p0820 BI: Drive data set selection, bit 0
- p0821 BI: Drive data set selection, bit 1
- p0822 BI: Drive data set selection, bit 2
- p0823 BI: Drive data set selection, bit 3
- p0824 BI: Drive data set selection, bit 4
- p0826 Motor changeover, motor number
- p0827 Motor changeover status word bit number
- p0828 Motor changeover, feedback signal
- p0830 Motor changeover, status
- p0831 Motor changeover, contactor feedback signal
- p0833 Data set changeover configuration

9.2.7 Friction characteristic curve

Description

The friction characteristic is used to compensate for the frictional torque of the motor and driven load. A friction characteristic allows the speed controller to be pre-controlled and improves the control response..

10 points along the characteristic are used for the friction characteristic. The coordinates of every point along the characteristic are defined by a speed parameter (p382x) and a torque parameter (p383x) (point 1 = p3820 and p3830).

Features

- There are 10 points along the characteristic to represent the friction characteristic.
- An automatic function supports the friction characteristic plot.
- A connector output (r3841) can be interconnected as friction torque (p1569).
- The friction characteristic can be activated and de-activated (p3842).

Commissioning

Speeds for making measurements as a function of the maximum speed p1082 are pre-assigned in p382x when commissioning the drive system for the first time. These can be appropriately changed corresponding to the actual requirements.

The automatic friction characteristic plot can be activated using p3845. The characteristic is then plotted the next time that it is enabled.

The following settings are possible:

- p3845 = 0 Friction characteristic plot de-activated
- p3845 = 1 Friction characteristic plot activated, all directions of rotation
  The friction characteristic is plotted in both directions of rotation. The result of the positive and negative measurement is averaged and entered into p383x.
- p3845 = 2 Friction characteristic plot activated, positive direction of rotation
- p3845 = 3 Friction characteristic plot activated, negative direction of rotation

⚠ DANGER

When the friction characteristic is plotted, the drive can cause the motor to move. As a result, the motor may reach maximum speed.

When commissioning the drive, the EMERGENCY STOP functions must function perfectly. To protect the machines and personnel, the relevant safety regulations must be observed.

Function diagram

FD 7010	Friction characteristic curve

Parameters

- p3820 Friction characteristic, value n0
- ...
- p3839 Friction characteristic, value M9
- r3840 Friction characteristic, status
- r3841 Friction characteristic, output
- p3842 Activate friction characteristic
- p3845 Activate friction characteristic plot

9.2.8 Increasing the output frequency

9.2.8.1 Description

In applications that require higher output frequencies, the pulse frequency of the converter may have to be increased.

The pulse frequency may also have to be changed to prevent resonance from occurring.

Since increasing the pulse frequency also increases the switching losses, a derating factor for the output current must be taken into account when the drive is configured.

Once the pulse frequency has been increased, the new output currents are automatically included in the calculation for power unit protection.

Note

Use of a sine-wave filter must be selected using p0230 = 3/4 when carrying out commissioning. This setting fixes the output frequency to 4 kHz or 2.5 kHz (this cannot be changed).

9.2.8.2 Default pulse frequencies

The specified maximum output frequencies can be achieved with the default pulse frequencies listed below.

Table 9-3 Maximum output frequency with default pulse frequency

Converter rating [kW]	Default pulse frequency [kHz]	Maximum output frequency [Hz]
Supply voltage 380 – 480 V 3 AC		
110 – 250	2	160
315 – 560	1.25	100
Supply voltage 500 – 600 V 3 AC		
110 – 560	1.25	100
Supply voltage 660 – 690 V 3 AC		
75 – 800	1.25	100

The pulse frequencies set in the factory are also the minimum frequencies.

The scanning times for the inputs and outputs of the customer terminal block TM31 are set in the factory to 4000 µs. This is also the minimum limit.

9.2.8.3 Increasing the pulse frequency

Description

The pulse frequency can be increased in a virtually continuously variable manner to between the value preassigned in the factory and the maximum pulse frequency which can be set.

Once the new pulse frequency required has been entered in p0113, a check is carried out to establish whether the required pulse frequency can be set.

1. The required frequency is used in the following formula:
   X = (0.5 x 1000)/p0113 µs
   If the result "X" is an integer multiple of 1.25 µs, the value is accepted. If not, alarm A1224 "Inconsistent pulse frequency" appears.
2. The following calculation will help obtain a permissible value for p0113:
   – Result "X" is divided by 1.25 µs and rounded up to the next whole number.
   – This result is then multiplied by 1.25 µs and converted to a recommended pulse frequency by reversing the above formula.
   – The recommended pulse frequency must be rounded up to 3 digits after the decimal place and entered in parameter p0113.
3. The scanning time for the customer terminal block TM31 (p4099[x]) must then be set to an integer multiple of the scanning time of p0115[0].
   The minimum limit for the setting range must be taken into account here.

Example

Factory setting: 1.25 kHz, required pulse frequency: 1.3 kHz.

1. (0.5 x 1000 µs)/1.3 = 384.61538461 µs
   is not an integer multiple of 1.25 µs – is not accepted.
2. Calculation of p0113:
   – 384.61538461 µs/1.25 µs = 307.692307688 => 308
   – 308 x 1.25 µs = 385 µs => r0114[1] = (0.5 x 1000 kHz)/385 = 1.2987 kHz
   – P0113 = 1.299 kHz
3. p0115[0] = 385 µs => p4099[0] = p4099[1] = p4099[2] = 11 x 385 µs = 4235 µs

Procedure for the setting in the above example

1. Set drive to pulse inhibit
2. DO1 (CU320): p0009 = 3 (drive basis configuration)
3. DO2 (VECTOR): p0112 = 0 (expert)
4. DO2 (VECTOR): p0113 = 1.299 kHz -> value is accepted
5. DO3 (TM31): p0112 = 0 (expert)
6. DO3 (TM31): p4099[0] = p4099[1] = p4099[2] = 4235 -> values are accepted
7. DO1 (CU320): p0009 = 0 -> calculations are made and a warm start is then carried out.

Note

The example described only applies to a SINAMICS G130 without a second customer terminal block TM31. When a second customer terminal block TM31 is used, steps 5 and 6 also have to be carried out for DO4 (2nd TM31).

9.2.8.4 Maximum output frequency achieved by increasing the pulse frequency

Maximum output frequencies achieved by increasing the pulse frequency

By multiplying the basis pulse frequency (with integers), the following output frequencies can be achieved (taking into account the derating factors):

Table 9-4 Maximum output frequency achieved by increasing the pulse frequency

Pulse frequency [kHz]	Maximum output frequency [Hz]
1.25	100
2	160
2.5	200
4	300 [1)]
5	300 [1)]

[1)] The maximum output frequency is limited to 300 Hz due to the closed-loop control.

9.2.8.5 Parameters

- p0009 Device commissioning parameter filter
- p0112 Sampling times pre-setting p0115
- p0113 Selects the minimum pulse frequency
- p0115 Sampling times
- p1800 Pulse frequency
- p4099 TM31 inputs/outputs, sampling time

9.2.9 Runtime (operating hours counter)

Total system runtime

The total system runtime is displayed in p2114 (Control Unit). Index 0 indicates the system runtime in milliseconds after reaching 86.400.000 ms (24 hours), the value is reset. Index 1 indicates the system runtime in days.

The value is saved when the system is switched off.
Once the drive unit has been switched on, the counter continues to run with the value that was saved the last time the drive was switched off.

Relative system runtime

The relative system runtime since the last POWER ON is displayed in p0969 (Control Unit). The value is in milliseconds and the counter is reset to 0 after 49 days.

Actual motor operating hours

The motor operating hours counter p0650 (drive) resumes when the pulses are enabled. When the pulse enable is withdrawn, the counter is stopped and the value saved.

To store the value, you need a CU320 with order number 6SL3040-....-0AA1 and version C or higher.

The counter is deactivated with p0651 = 0.

If the maintenance interval set in p0651 is reached, fault F01590 is triggered. Once the motor has been maintained, the maintenance interval must be reset.

Operating hours counter for the fan

The operating hours of the fan in the power unit are displayed in p0251 (drive).

The number of hours operated can only be reset to 0 in this parameter (e.g. after a fan has been replaced).

The service life of the fan is entered in p0252 (drive).

Alarm A30042 is output 500 hours before this figure is reached.

Monitoring is deactivated with p0252 = 0.

9.2.10 Simulation operation

Description

The simulation function is predominantly used to simulate the drive without a motor being connected and without a DC link voltage. In this case, it should be noted that the simulation mode can only be activated under an actual DC link voltage of 40 V. If the voltage lies above this threshold, the simulation mode is reset, and a fault message F07826 is issued.

Communications with a higher-level automation system can be tested using the simulation mode. If the drive is also to return actual values, note that it must be switched over to encoderless operation during simulation mode. This means that large parts of the SINAMICS software (e.g., software channel, sequence control, communications, technology function, etc.) can be tested in advance without requiring a motor.

Another application is to test the correct functioning of the Power Module. Especially for drive units with higher power ratings 75 kW (690 V) and 110 kW (400 V), after repairs, it is necessary to test the gating of the power semiconductors. This is done by injecting a low DC voltage as DC link voltage (e.g. 12 V). The drive unit is then powered-up and the pulses enabled. It must be possible to run through all of the pulse patterns of the gating unit software.

This means that the software must allow the pulses to be switched-in and various frequencies approached. If a speed encoder is not being used, then this is generally implemented using V/f control or sensorless closed-loop speed control.

Note

The following functions are de-activated in the simulation mode:

- Motor data identification
- Motor data identification, rotating without encoder
- Pole position identification

No flying restart is carried-out for V/f control and sensorless closed-loop vector control.

Commissioning

Simulation is activated using p1272 = 1; the following pre-requisites must be fulfilled:

- The drive unit must have been commissioned for the first time (default: Standard induction motors).
- The DC link voltage must lie below 40 V (observe the tolerance of the DC link voltage sensing).

Alarm A07825 (simulation mode activated) must be output during simulation operation.

Parameters

- p1272 Simulation operation

9.2.11 Direction reversal

Description

The direction of rotation of the motor can be reversed using direction reversal via p1821 without having to change the motor rotating field by interchanging two phases on the motor and inverting the encoder signals using p0410.

Reversal via p1821 can be detected from the motor direction of rotation. The speed setpoint and actual value, torque setpoint and actual value remain unchanged, as does the relative position change.

A pulse inhibit must be set prior to attempting reversal.

Reversing can be set differently for each drive data set.

Note

When changing over the drive data set to differently set reversing and with pulse approval, fault F7434 is issued.

Reversing can be observed by checking parameters r0069 (phase currents) and r0089 (phase voltage). The absolute position reference is lost on reversal.

Function diagram

FD 4704, 4715	Encoder evaluation
FD 6730, 6731	Current control

Parameters

- r0069 Phase currents actual value
- r0089 Phase voltage actual value
- p1820 Output phase direction reversal
- p1821 Direction reversal

9.2.12 Unit switchover

Description

Parameters and process variables for input and output can be switched to a suitable units system (SI units, US units or referenced variables (%)) with the help of the unit changeover function.

The following constraints apply to the unit changeover:

- Unit changeover is only possible for the "VECTOR" drive object.
- Type plate parameters of the converter and/or motor can be changed between SI/US units but not to a referenced form of depiction.
- Once the changeover parameters have been changed over, all parameters which are assigned to a group of dependent units are jointly changed over to the new unit.
- A separate parameter is available for selecting technological units (p0595) for the representation of technological variables in the technology controller.
- If a changeover is made to referenced variables and the reference variable is subsequently changed, the % value entered in a parameter will not change.

  Example:

  – With a reference speed of 1500 1/min, a fixed speed of 80 % corresponds to a value of 1200 1/min.
  – If the reference speed is changed to 3000 1/min, the value of 80 % is retained and is now 2400 1/min.

Restrictions

- Values are rounded to decimal places in the context of unit changeover. This can mean that the original value might change by up to one decimal place.
- If a referenced form is selected and the reference parameters (e.g., p2000) are changed retrospectively, the referenced value of some of the control parameters will also be adjusted to ensure that the control response is unaffected.
- Changing the reference variables (p2000 to p2007) in the STARTER in offline mode can cause parameter value limit violations, leading in turn to error messages when the values are loaded to the drive unit.

Changing over the units

The units can be changed over via AOP30 and via the STARTER.

- Unit changeover via AOP30 is always undertaken immediately. Once the corresponding parameters have been changed, the values affected are displayed in the new selected unit.
- If operating using the STARTER, the unit changeover can only take place in offline mode in the configuration screen of the corresponding drive object. The new units are only displayed after the download ("Load project in target system") and subsequent upload ("Load project in PG").

Unit groups

Each parameter which can be changed over is assigned to a unit group which can be changed over within certain limits depending on the group.

This assignment and the units groups for each parameter appear in the parameter list in the SINAMICS Parameter Manual.

4 parameters (p0100, p0349, p0505 and p0595) are available for changing over the units groups individually.

Parameters

- p0010 Commissioning parameter filter
- p0100 IEC/NEMA mot stds
- p0349 Selection of units system, motor equivalent circuit diagram data
- p0505 Selection of units system
- p0595 Selection of technological unit
- p0596 Reference variable of technological unit
- p2000 Reference frequency/speed
- p2001 Reference voltage
- p2002 Reference current
- p2003 Reference torque
- p2004 Reference power
- p2005 Reference angle
- p2007 Reference acceleration

9.2.13 Derating behavior at increased pulse frequency

Description

To reduce motor noise or to increase output frequency, the pulse frequency can be increased relative to the factory setting.

The increase in the pulse frequency normally results in a reduction of the maximum output current (see "Technical data/current derating depending on the pulse frequency").

When commissioning the converter the behavior at overload is adjusted in such a manner that the pulse frequency is variably reduced so that the required power can be obtained.

Characteristics:

- The reaction to overload depends on the setting of parameter p0290:
  - p0290 = 0: Reduce output current or output frequency
  - p0290 = 1: No reduction, shutdown when overload threshold is reached
  - p0290 = 2: Reduce the output current or output and pulse frequency (not using I^2t).
  - p0290 = 3: Reduce the pulse frequency (not using I^2t)
- Bei p0290 = 2 at overload first reduce the pulse frequency until it has dropped to rated pulse frequency, then reduce the output frequency if overload continues to persist.
- Reduction of the pulse frequency is executed in whole multiples based on the rated pulse frequency (5 kHz -> 2.5 kHz -> 1.25 kHz or 4 kHz -> 2 kHz).
- After entering the maximum speed in p1082 the system automatically calculates whether the pulse frequency is sufficient for the entered maximum speed, if necessary the pulse frequency is increased automatically to a value that is necessary for this.
  At overload, then also for p0290 = 2 or 3, this new pulse frequency will no longer be underranged, the downstream reaction (reduce output voltage or switch off) will be triggered.

Exceptions:

- With an activated sinus filter (p0230 = 3, 4), this behavior is not permitted because the factory set pulse frequency (2.5 kHz or 4 kHz) should not be changed through this measure. Consequently in this case the selection possibility for the parameter p0290 is limited to "0" and "1".

Activation of the variable pulse frequency

At commissioning the parameter p 0290 is automatically set to the value "2". This activates pulse frequency reduction at overload.

Deactivation of the variable pulse frequency

By changing the parameter p0290 to "0" or "1" the variable pulse frequency is deactivated.

Function diagram

FD 8014	Signals and monitoring functions - thermal monitoring power unit

Parameter

- r0036 Power unit overload I2t
- r0037 CO: Power unit temperatures
- p0230 Drive filter type, motor side
- p0290 Power unit overload response
- p1082 Maximum speed
- r2135.13 Fault thermal overload power unit
- r2135.15 Thermal overload in power unit alarm

9.3 Extended functions

9.3.1 Technology controller

Description

The "technology controller" function module allows simple control functions to be implemented, e.g.:

- Liquid level control
- Temperature control
- Dancer position control
- Pressure control
- Flow control
- Simple control without higher-level control
- Tension control

The technology controller features:

- Two scalable setpoints
- Scalable output signal
- Separate fixed values
- Separate motorized potentiometer
- The output limits can be activated and deactivated via the ramp-function generator.
- The D component can be switched to the system deviation or actual value channel.
- The motorized potentiometer of the technology controller is only active when the drive pulses are enabled.

The technology controller is designed as a PID controller, whereby the differentiator can be switched to the control deviation channel or the actual value channel (factory setting). The P, I, and D components can be set separately.

A value of 0 deactivates the corresponding component. Setpoints can be specified via two connector inputs. The setpoints can be scaled via parameters p2255 and p2256.

A ramp-function generator in the setpoint channel can be used to set the setpoint ramp-up/ramp-down time via parameters p2257 and p2258. The setpoint and actual value channel each have a smoothing element. The smoothing time can be set via parameters p2261 and p2265.

The setpoints can be specified via separate fixed setpoints (p2201 to p2215), the motorized potentiometer, or via the field bus (e.g. PROFIBUS).

Pre-control can be integrated via a connector input.

The output can be scaled via parameter p2295 and the control direction reversed. It can be limited via parameters p2291 and p2292 and interconnected as required via a connector output (r2294).

The actual value can be integrated, for example, via an analog input on the TM31.

If a PID controller has to be used for control reasons, the D component is switched to the setpoint/actual value difference (p2263 = 1) unlike in the factory setting. This is always necessary when the D component is to be effective, even if the reference variable changes. The D component can only be activated when p2274 > 0.

Note

With the entry "0" sec. as power up time or ramp-down time for the ramp function generator of the technology controller, the current values of the respective ramp function generator will be frozen.

Commissioning

The "technology controller" function module can be activated by running the commissioning Wizard. Parameter r0108.16 indicates whether the function module has been activated.

Function diagram

FD 7950	Technology controller – fixed values
FD 7954	Technology controller – motorized potentiometer
FD 7958	Technology controller – closed-loop controller

Example: liquid level control

The objective here is to maintain a constant level in the container.

This is carried out by means of a variable-speed pump in conjunction with a sensor for measuring the level.

The level is determined via an analog input (e.g. AI0 TM31) and sent to the technology controller. The level setpoint is defined in a fixed setpoint. The resulting controlled variable is used as the setpoint for the speed controller.

In this example, a Terminal Module (TM31) is used.

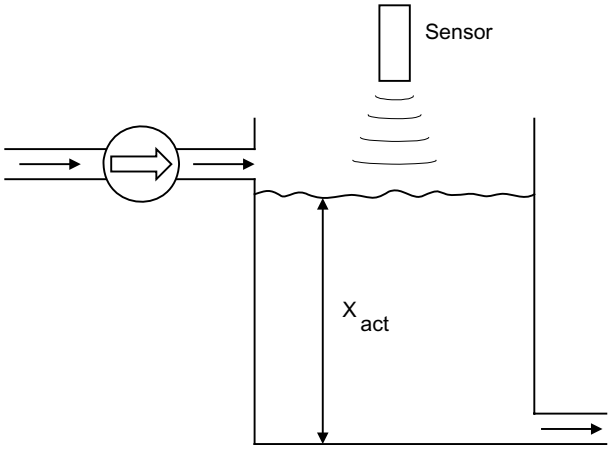


Figure 9-8 Level control: Application

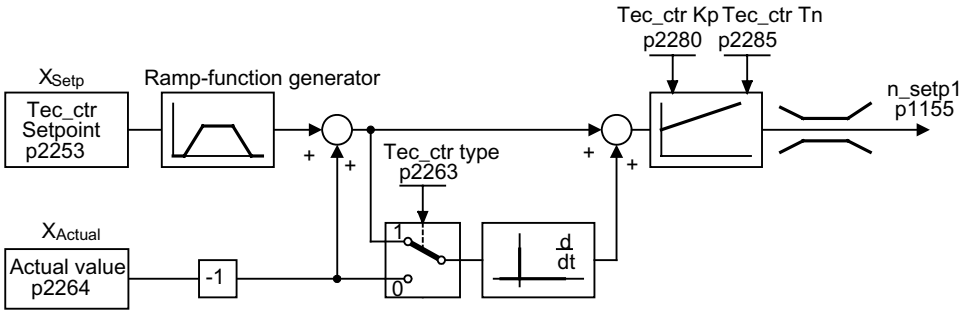


Figure 9-9 Level control: Controller structure

Key control parameters

- p1155 = r2294 n_setp1 downstream of RFG [FD 3080]
- p2253 = r2224 Technology controller setpoint effective via fixed setpoint [FD 7950]
- p2263 = 1 D component in fault signal [FD 7958]
- p2264 = r4055 Actual value signal X_{actual} via AI0 of TM31 [FP 9566]
- p2280 = Kp Calculate P gain by means of optimization
- p2285 = Tn Calculate integral time by means of optimization
- p2200 = 1 Technology controller enabled

9.3.2 Bypass function

The bypass function uses digital converter outputs to activate two contactors and uses digital inputs to evaluate the contactor's feedback (e.g. via TM31). This circuit allows the motor to be operated using the converter or directly on the supply line. The contactors are activated by the converter. The feedback signals for the contactor positions have to be returned to the converter.

The bypass circuit can be implemented in two ways:

- without synchronizing the motor to the supply and
- with synchronizing the motor to the supply.

The following applies to all bypass versions:

- The bypass switch is also shut down when one of the "OFF2" or "OFF3" control word signals is canceled.
- Exception:
  If necessary, the bypass switch can be interlocked by a higher-level controller such that the converter can be shut down completely (i.e. including the controller electronics) while the motor is operated on the supply.
  The protective interlocking must be implemented on the system side.
- When the converter is started up again after POWER OFF, the status of the bypass contactors is evaluated. After powering up, the converter can thereby change straight into "Ready to start and bypass" status. This is only possible if the bypass is activated via a control signal, the control signal (p1266) is still present once the system has been ramped up, and the automatic restart function (p1200 = 4) is active.
- Changing the converter into "Ready to start and bypass" status after powering up, is of a higher priority than switching back on automatically.
- Monitoring of the motor temperatures using temperature sensors is active while the converter is in one of two statuses "Ready to start and bypass" or "Ready to operate and bypass".
- The two motor contactors must be designed for switching under load.

Note

The examples contained in the following descriptions are only basic circuits designed to explain the basic function. The dimensions of specific circuit configurations (contactors, protective equipment) must be calculated for specific systems.

Prerequisites

The bypass function is only available for sped control without encoders (p1300 = 20) or V/f-control (p1300 = 0...19) and when using an asynchronous motor.

Establishing the bypass function

The bypass function is part of the "technology controller" function module that can be activated by running the commissioning Wizard. Parameter r0108.16 indicates whether the function module has been activated.

9.3.2.1 Bypass with synchronizer with degree of overlapping (p1260 = 1)

Description

When “Bypass with synchronizer with degree of overlapping (p1260 = 1)” is activated, the synchronized motor is transferred to the supply and retrieved again. During the changeover, both contactors K1 and K2 are closed at the same time for a period (phase lock synchronization).

A restrictor is used to disconnect the converter and supply voltage. The uk value for the restrictor is 10% ± 2%.

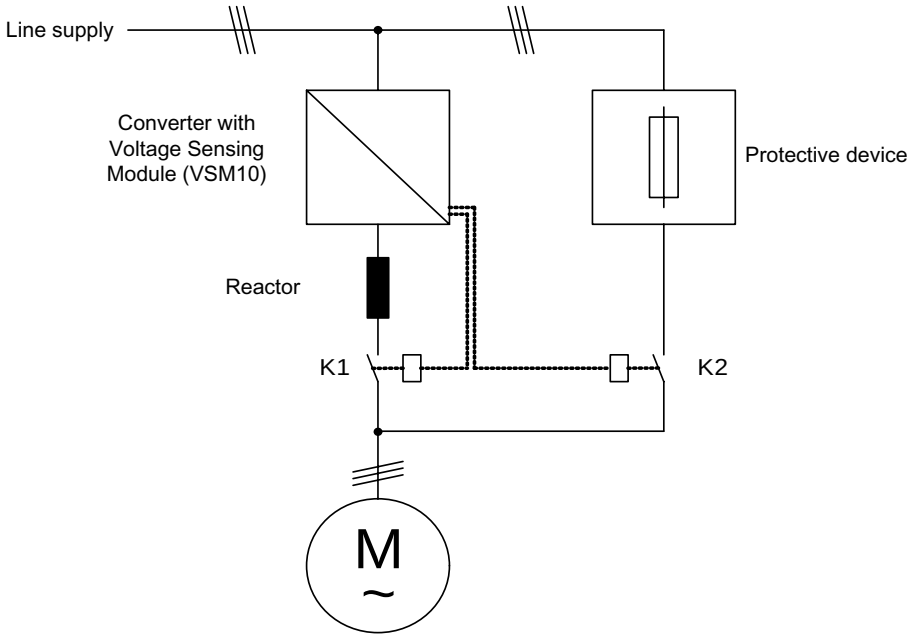


Figure 9-10 Typical circuit diagram for bypass with synchronizer with degree of overlapping

Activation

The function with synchronizer with degree of overlapping (p1260 = 1) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer with degree of overlapping (p1260 = 1) function has been activated, the following parameters must be set:

Table 9-5 Parameter settings for bypass function with synchronizer with degree of overlapping

Parameters	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.

Transfer process

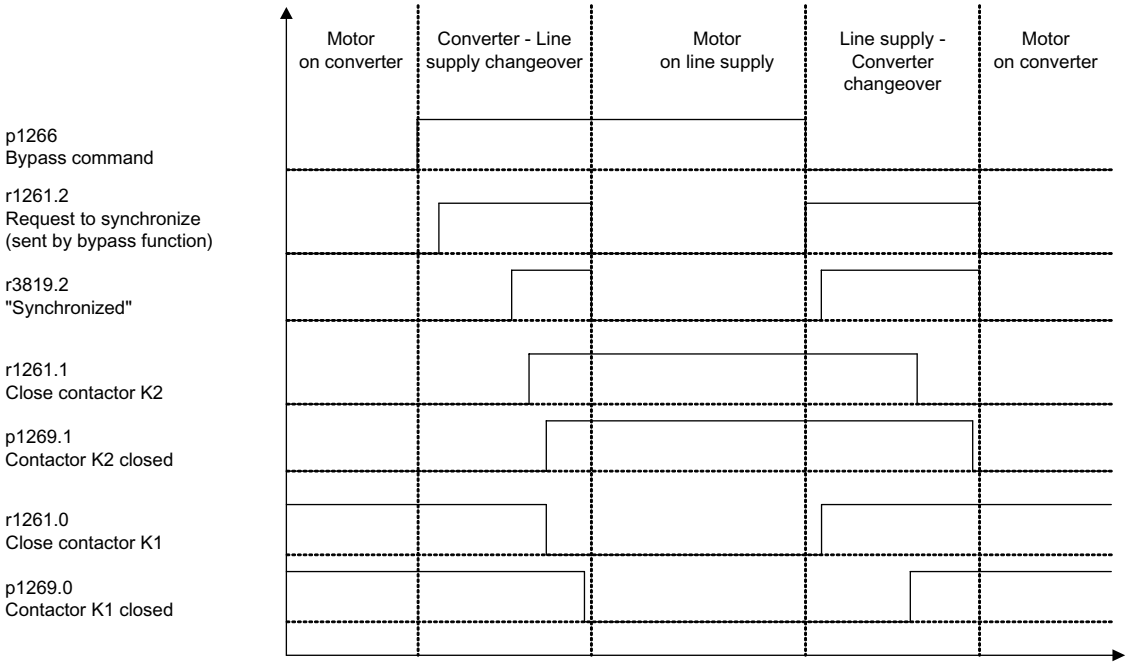


Figure 9-11 Signal diagram, bypass with synchronization with overlap

Transfer of motor to line supply
(contactors K1 and K2 are activated by the converter):

- The initial state is as follows: Contactor K1 is closed, contactor K2 is open and the motor is fed from the converter.
- The control bit "bypass command" (p1266) is set (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing" (r1261.2).

- Since the bit is set while the converter is running, the "Transfer motor to line supply" synchronization process is started.
- Once motor synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state (r3819.2).
- The bypass mechanism evaluates this signal and closes contactor K2 (r1261.1 = 1). The signal is evaluated internally - BICO wiring is not required.
- After contactor K2 has fed back the "closed" state (r1269[1] = 1), contactor K1 is opened and the converter inhibits the pulses. The converter is in "Ready for operation and bypass" state.
- If the On command is cancelled in this phase, the converter will change to "Ready to start and bypass" status. If the appropriate contactors are being used, the converter will be isolated from the line supply and the DC link discharged.

To transfer the motor back from the line supply, the sequence is simply reversed: At the start of the process, contactor K2 is closed and contactor K1 is open.

- The "Command bypass" control bit is canceled (e.g., by the higher-level automation).
- The bypass function sets the control word bit "synchronizing".
- The pulses are enabled. Since "synchronizing" is set before "pulse enable", the converter interprets this as a command to retrieve the motor from the line supply.
- Once converter synchronization to line frequency, line voltage and line phasing is complete, the synchronization algorithm reports this state.
- The bypass mechanism evaluates this signal and closes contactor K1. The signal is evaluated internally - BICO wiring is not required.
- Once contactor K1 has reported "closed" status, contactor K2 is opened and the motor returns to operation on the converter.

9.3.2.2 Bypass with synchronizer without degree of overlapping (p1260 = 2)

Description

When “Bypass with synchronizer without degree of overlapping (p1260 = 2)” is activated, contactor K2 (to be closed) is only closed when contactor K1 is opened (anticipatory type synchronization). Phasing of the motor voltage before synchronization must be set such that there is an "initial jump" upstream of the supply to which synchronization should be carried out. This done by setting the synchronization setpoint (p3809). A phase and frequency difference of around zero is produced when closing contactor K2 by braking the motor in the brief period in which both contactors are open.

In order for the function to run correctly, the moment of inertia must be sufficient.

Due to the expense of determining the synchronization setpoint (p3809), the decoupling restrictor is not needed.

The "flying restart" function must be activated (p1200 = 1).

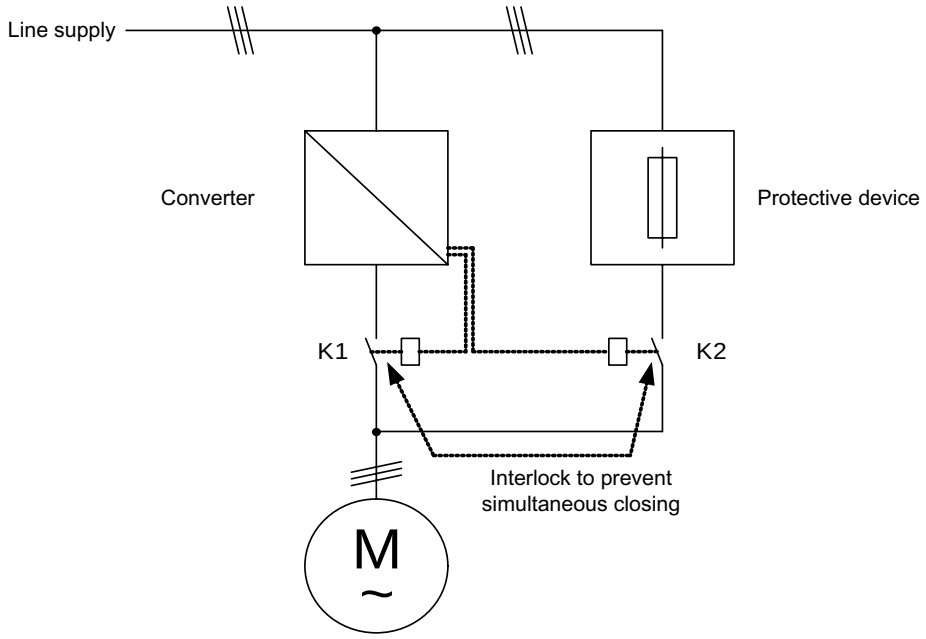


Figure 9-12 Example circuit for bypass with synchronizer without degree of overlapping

Activation

The bypass with synchronizer without degree of overlapping (p1260 = 2) function can only be activated using a control signal. It cannot be activated using a speed threshold or a fault.

Parameterization

Once the bypass with synchronizer without degree of overlapping (p1260 = 2) function has been activated, the following parameters must be set:

Table 9-6 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameters	Description
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = 1 p1267.1 = 0	Bypass function is initiated by the control signal
p1269[0] =	Signal source for contactor K1 feedback
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
p1200 = 1	The "flying restart" function is always active.

9.3.2.3 Bypass without synchronizer (p1260 = 3)

Description

When the motor is transferred to the supply, contactor K1 is opened (following converter's pulse inhibit). The system then waits for the motor excitation time to elapse after which contactor K2 is closed and the motor is run directly on the supply.
If the motor is switched on in a non-synchronized manner, when activated an equalizing current flows and this must be taken into account when designing the protective equipment (see diagram "Circuit bypass without synchronization").

When the motor is being transferred from the supply by the converter, initially contactor K2 is opened and after the excitation time, contactor K1 is closed. The converter then captures the rotating motor and the motor is operated on the converter.

Contactor K2 must be designed for switching under load.

Contactors K1 and K2 must be interlocked against closing at the same time.

The "flying restart" function must be activated (p1200 = 1).

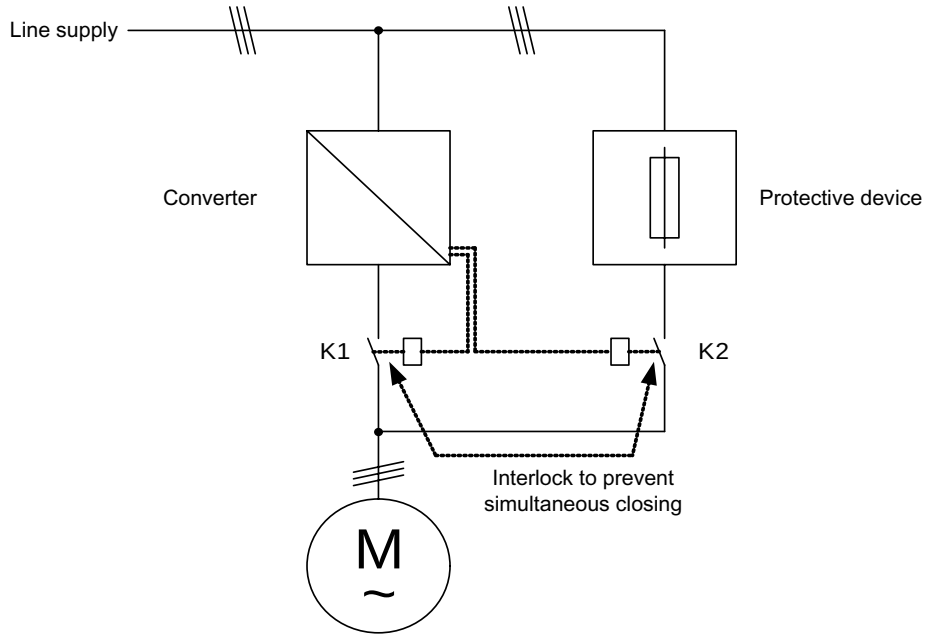


Figure 9-13 Example circuit for bypass without synchronization

Activation

The bypass with synchronizer (p1260 = 3) can be triggered by the following signals (p1267):

- Bypass by means of control signal (p1267.0 = 1):
  The bypass can be activated by means of a digital signal (p1266) (e.g. from a higher-level automation system). If the digital signal is canceled, a changeover to converter operations is triggered once the debypass delay time (p1263) has expired.

- Bypass at speed threshold (p1267.1 = 1):
  Once a certain speed is reached, the system switches to bypass (i.e. the converter is used as a start-up converter). The bypass cannot be connected until the speed setpoint is greater than the bypass speed threshold (p1265).
  The system reverts to converter mode when the setpoint (on the input of the ramp-function generator, r1119) falls below the bypass speed threshold (p1265). The setpoint > comparison value condition prevents the bypass from being reactivated straight away if the actual speed is still above the bypass speed threshold (p1265) after switching back to converter operations.

The bypass time, debypass time, bypass speed variables and the command source for changing over are set using parameters.

Parameterization

Once the bypass without synchronizer (p1260 = 3) function has been activated, the following parameters must be set:

Table 9-7 Parameter settings for bypass function with synchronizer without degree of overlapping

Parameter	Description
p1262 =	Bypass dead time setting
p1263 =	Debypass dead time setting
p1264 =	Bypass delay time setting
p1265 =	Speed threshold setting when p1267.1 = 1
p1266 =	Control signal setting when p1267.0 = 1
p1267.0 = p1267.1 =	Trigger signal setting for bypass function
p1269[1] =	Signal source for contactor K2 feedback
p3800 = 1	The internal voltages are used for synchronization.
p3802 = r1261.2	Synchronizer activation is triggered by the bypass function.
P1200 = 1	The "flying restart" function is always active.

9.3.2.4 Function diagram

FP 7020 Synchronization

9.3.2.5 Parameters

Bypass function

- p1200 Flying restart operating mode
- p1260 Bypass configuration
- r1261 CO/BO: Bypass control/status word
- p1262 Bypass dead time
- p1263 Debypass delay time
- p1264 Bypass delay time
- p1265 Bypass speed threshold
- p1266 BI: Bypass control command
- p1267 Bypass changeover source configuration
- p1268 BI: Bypass feedback signal synchronization completed
- p1269 BI: Bypass switch feedback signal
- p1274 BI: Bypass switch monitoring time

Synchronization

- p3800 Sync–supply–drive activation
- p3801 Sync–supply–drive drive object number
- p3802 BI: Sync–supply–drive enable
- r3803 CO/BO: Sync–supply–drive control word
- r3804 CO: Sync–supply–drive target frequency
- r3805 CO: Sync–supply–drive frequency difference
- p3806 Sync–supply–drive frequency difference threshold
- r3808 CO: Sync–supply–drive phase difference
- p3809 Sync–supply–drive phase setpoint
- p3811 Sync–supply–drive frequency limitation
- r3812 CO: Sync–supply–drive correction frequency
- p3813 Sync–supply–drive phase synchronism threshold
- r3814 CO: Sync–supply–drive voltage difference
- p3815 Sync–supply–drive voltage difference threshold
- r3819 CO/BO: Sync–supply–drive status word

9.3.3 Extended brake control

Description

The "extended braking control" function module allows complex braking control for motor holding brakes and operational brakes.

The brake is controlled as follows (the sequence reflects the priority):

- Via parameter p1215
- Via binector parameters p1219[0..3] and p0855
- Via zero speed detection
- Via a connector interconnection threshold value

Commissioning

The "extended braking control" function module can be activated by running the commissioning Wizard. Parameter r0108.14 indicates whether the function module has been activated.

Parameter p1215 must be set to "3" and the brake controlled via a digital output on customer terminal strip TM31.

Function diagram

FD 2704	Zero speed detection
FD 2707	Release/apply brake
FD 2711	Signal outputs

Example 1: Starting against applied brake

When the device is switched on, the setpoint is enabled immediately (if other enable signals are issued), even if the brake has not yet been released (p1152 = 1). The factory setting p1152 = r0899.15 must be separated here. The drive starts by generating a torque against the applied brake. The brake is not released until the motor torque or motor current (p1220) has exceeded braking threshold 1 (p1221).

This configuration is used, for example, when the drive is connected to a belt that is under tension (loop accumulator in the steel industry).

Example 2: Emergency brake

If emergency braking is required, electrical and mechanical braking is to take place simultaneously. This can be achieved if OFF3 is used as a tripping signal for emergency braking:

p1219[0] = r0898.2 (OFF3 to "apply brake immediately").

To prevent the converter working in opposition to the brake, the OFF3 ramp (p1135) should be set to 0 seconds. Any prevailing regenerative energy must be converted into heat via a braking resistor.

This is often used, for example, in calendar stacks, cutting tools, running gears, and presses.

Example 3: Service brake on crane drives

For cranes with manual control, it is important that the drive responds immediately when the control lever is moved (master switch). To this end, the drive is powered up using the on command (p0840) (the pulses are enabled). Speed setpoint (p1142) and speed controller (p0856) are inhibited. The motor is magnetized. The magnetization time generally applicable for three-phase motors (1-2 seconds) is, therefore, eliminated.

Now, only the brake opening time will delay the motor starting to rotate following activation of the master switch. Movement of the master switch generates a "setpoint enable from the control" (bit interconnected with p1142, p1229.2, p1224.0). The speed controller is enabled immediately and the speed setpoint is enabled once the brake opening time (p1216) has elapsed. When the master switch is in the zero position, the speed setpoint is inhibited and the drive ramps down along the ramp-function generator's ramp-down ramp. The brake closes once the standstill limit (p1226) is undershot. Once the brake closing time (p1217) has elapsed, the speed controller is inhibited (the motor is no longer generating any force). Extended braking control is used with the modifications described below.

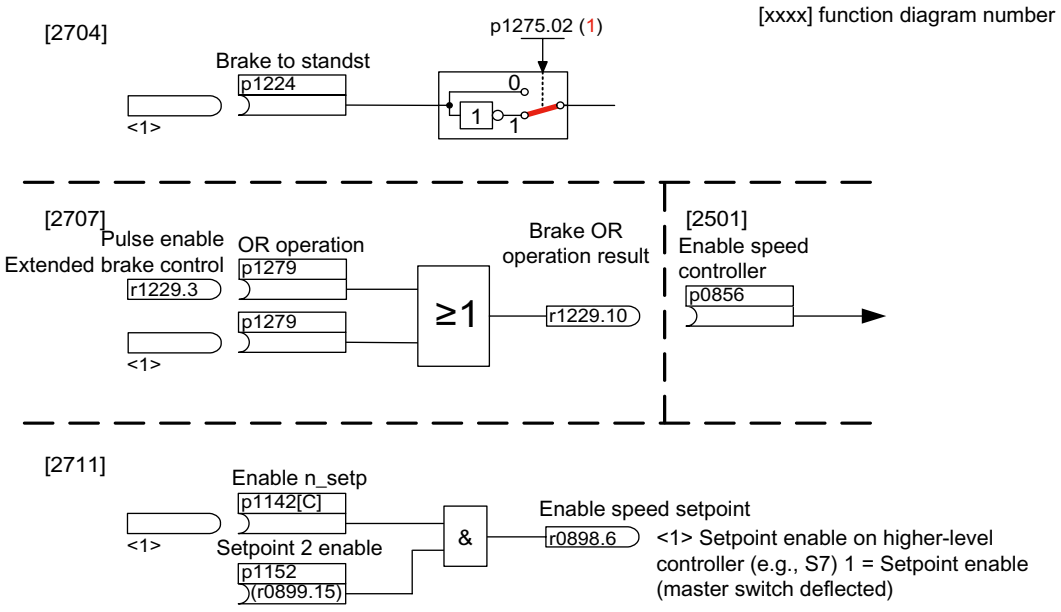


Figure 9-14 Example: Service brake on a crane drive

9.3.4 Extended monitoring functions

Description

The "extended monitoring functions" function module enables additional monitoring functions:

- Speed setpoint monitoring: |n_setp| ≤ p2161
- Speed setpoint monitoring: n_set > 0
- Load monitoring

Description of load monitoring

This function monitors power transmission between the motor and the working machine. Typical applications include V-belts, flat belts, or chains that loop around the belt pulleys or cog wheels for drive and outgoing shafts and transfer the peripheral speeds and forces. Load monitoring can be used here to identify blockages in the working machine and interruptions to the power transmission.
During load monitoring, the current speed/torque curve is compared with the programmed speed/torque curve (p2182 – p2190). If the current value is outside the programmed tolerance bandwidth, a fault or alarm is triggered depending on parameter p2181. The fault or alarm message can be delayed by means of parameter p2192 to prevent false alarms caused by brief transitional states.

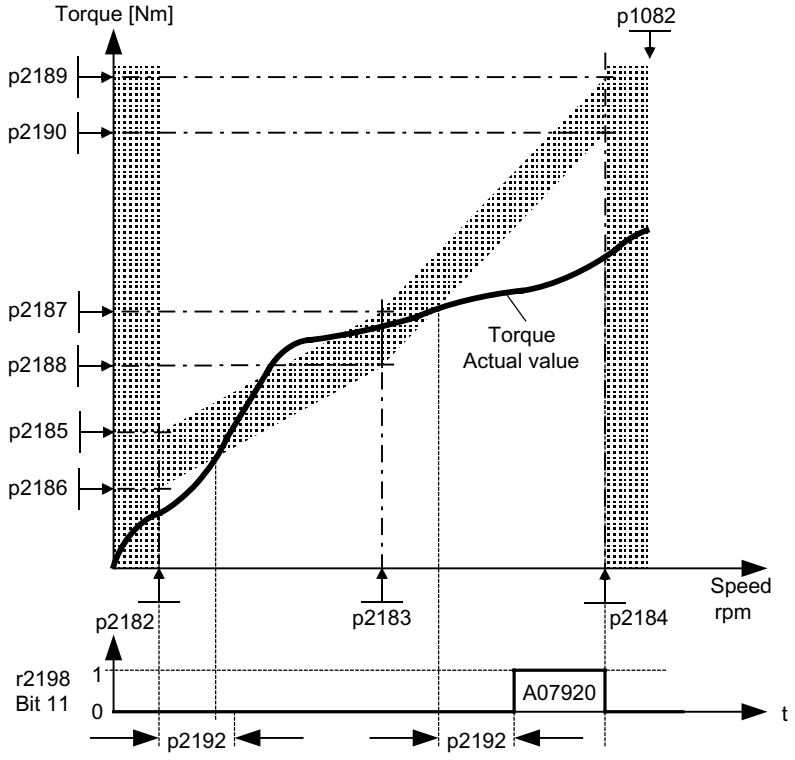


Figure 9-15 Load monitoring (p2181 =1)

Commissioning

The "extended monitoring functions" function module can be activated by running the commissioning wizard. Parameter r0108.17 indicates whether it has been activated.

Function diagram

FD 8010	Speed messages
FD 8013	Load monitoring

Parameters

- p2150 Hysteresis speed 3
- p2151 CI: Speed setpoint
- p2161 Speed threshold 3
- p2181 Load monitoring, response
- p2182 Load monitoring, speed threshold 1
- p2183 Load monitoring, speed threshold 2
- p2184 Load monitoring, speed threshold 3
- p2185 Load monitoring, speed threshold 1 upper
- ...
- p2190 Load monitoring, speed threshold 3 lower
- p2192 Load monitoring, delay time
- r2198.4 BO: ZSW monitoring 2, |n_setp| ≤ p2161
- r2198.5 BO: ZSW monitoring 2, n_setp < 0

9.4 Monitoring and protective functions

9.4.1 Protecting power components

Description

SINAMICS power units offer comprehensive functions for protecting power components.

Table 9-8 General protection for power units

Protection against:	Protective measure	Response
Overcurrent[1)]	Monitoring with two thresholds: • First threshold exceeded	A30031, A30032, A30033 Current limiting in phase U has responded. Pulsing in this phase is inhibited for one pulse period. F30017 -> OFF2 is triggered if the threshold is exceeded too often.
	• Second threshold exceeded	F30001 "Overcurrent" -> OFF2
Overvoltage[1)]	Comparison of DC link voltage with hardware shutdown threshold	F30002 "Overvoltage" -> OFF2
Undervoltage[1)]	Comparison of DC link voltage with hardware shutdown threshold	F30003 "Undervoltage" -> OFF2
Short-circuit[1)]	Second monitoring threshold checked for overcurrent Uce monitoring for IGBT module	F30001 "Overcurrent" -> OFF2 F30022 "Monitoring Uce" -> OFF2
Ground fault	Monitoring the sum of all phase currents	After threshold in p0287 is exceeded: F30021 "power unit: Ground fault" -> OFF2 Note: The sum of all phase currents is displayed in r0069[6]. For operation, the value in p0287[1] must be greater than the sum of the phase currents when the insulation is intact.
Line phase-failure detection [1)]		F30011 "Line phase-failure in main circuit" -> OFF2

[1)] The monitoring thresholds are permanently set in the converter and cannot be changed by the user.

9.4.2 Thermal monitoring and overload responses

Description

The priority of thermal monitoring for power components is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options that enable continued operation (e.g. with reduced power) and prevent immediate shutdown. The parameterization options, however, only enable intervention below the shutdown thresholds, which cannot be changed by the user.

The following thermal monitoring options are available:

- i²t monitoring – A07805 – F30005
  i²t monitoring is used to protect components that have a high thermal time constant compared with semi-conductors. Overload with regard to i²t is present when the converter load (r0036) is greater than 100% (load in % in relation to rated operation).
- Heatsink temperature – A05000 – F30004
  Monitoring of the heat-sink temperature (r0037) of the power semi-conductor (IGBT).
- Chip temperature – A05001 – F30025
  Significant temperature differences can occur between the barrier layer of the IGBT and the heatsink. These differences are taken into account and monitored by the chip temperature (r0037).

If an overload occurs with respect to any of these three monitoring functions, an alarm is first output. The alarm threshold p0294 (i²t monitoring) can be parameterized relative to the shutdown (trip) values.

Example

The factory setting for the alarm threshold for chip temperature monitoring is 15 Kelvin (K), and 5 K for the heat sink and inlet air. This means that the "Overtemperature, overload" alarm is triggered at 15 K or 5 K below the shutdown threshold.

The parameterized responses are induced via p0290 simultaneously when the alarm is output. Possible responses include:

- Reduction in pulse frequency (p0290 = 2, 3)
  This is a highly effective method of reducing losses in the power unit, since switching losses account for a high proportion of overall losses. In many applications, a temporary reduction in the pulse frequency can be tolerated to allow the process to continue.
  Disadvantage:
  As a result of the pulse frequency reduction, the current ripple is increased which can mean that the torque ripple is increased at the motor shaft (for low moments of inertia) and also an increased noise level. Reducing the pulse frequency does not affect the dynamic response of the current control circuit, since the sampling time for the current control circuit remains constant.
- Reducing the output frequency (p0290 = 0, 2)
  This variant is recommended when you do not need to reduce the pulse frequency or the pulse frequency has already been set to the lowest level. The load should also have a characteristic similar to a fan, that is, a quadratic torque characteristic with falling speed. Reducing the output frequency has the effect of significantly reducing the converter output current which, in turn, reduces losses in the power unit.

- No reduction (p0290 = 1)
  You should choose this option if it is neither possible to reduce the pulse frequency nor reduce the output current. The converter does not change its operating point once an alarm threshold has been overshot, which means that the drive can be operated until it reaches its shutdown values. Once it reaches its shutdown threshold, the converter switches itself off and the "Overtemperature, overload" fault is output. The time until shutdown, however, is not defined and depends on the degree of overload. To ensure that an alarm can be output earlier or that the user can intervene, if necessary, in the drive process (e.g. reduce load/ambient temperature), only the alarm threshold can be changed.

Function diagram

FD 8014 Thermal monitoring, power unit

Parameters

- r0036 Power Module overload
- r0037 Power Module temperatures
- p0290 Power Module overload response
- p0294 Power Module alarm with i²t overload

9.4.3 Block protection

Description

The error message "Motor blocked" is only triggered if the speed of the drive is below the variable speed threshold set in p2175. With vector control, it must also be ensured that the speed controller is at the limit. With V/f control, the current limit must already have been reached.
Once the ON delay (p2177) has elapsed, the message "Motor blocked" and fault F7900 are generated.

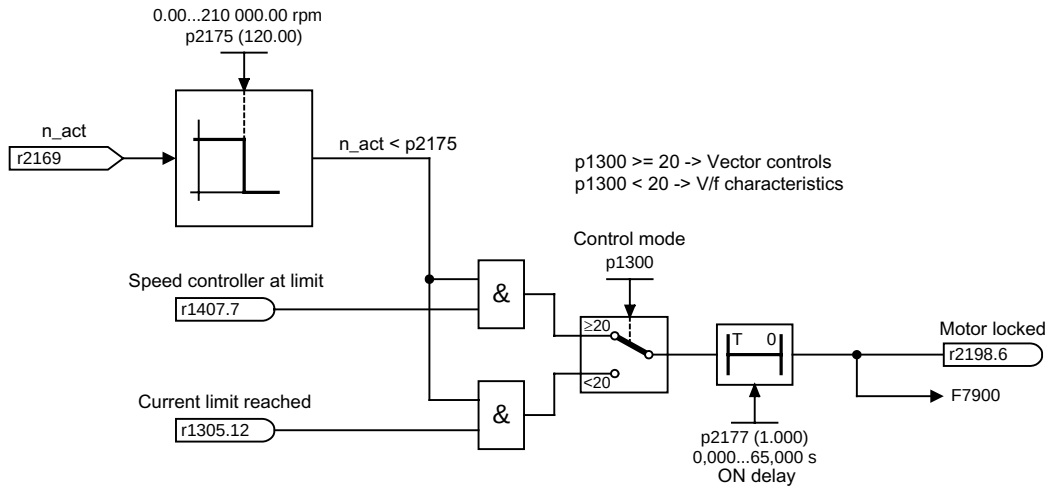


Figure 9-16 Blocking protection

Function diagram

FD 8012 Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- p2175 Speed threshold motor blocked
- p2177 Delay time motor blocked

9.4.4 Stall protection (only for vector control)

Description

If, for closed-loop speed control with encoder, the speed threshold set in p1744 for stall detection is exceeded, then r1408.11 (speed adaptation, speed deviation) is set.

If the fault threshold value set in p1745 is exceeded when in the low speed range (less than p1755 x p1756), r1408.12 (motor stalled) is set.

If one of the two signals is set, then after the delay time in p2178, fault F7902 (motor stalled) is output.

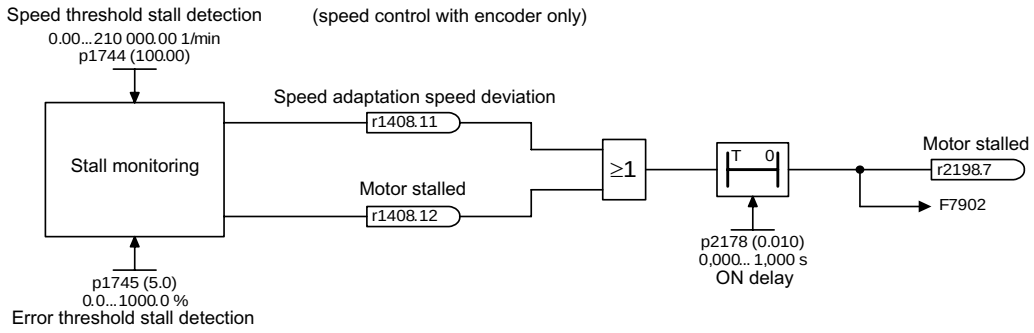


Figure 9-17 Stall protection

Function diagram

FD 6730	Current control
FD 8012	Messages and monitoring - Torque messages, motor blocked/stalled

Parameters

- r1408 CO/BO: Control status word 3
- p1744 Motor model speed threshold stall detection
- p1745 Motor model error threshold stall detection
- p1755 Motor model changeover speed encoderless operation
- p1756 Motor model changeover speed hysteresis
- p2178 Delay time motor stalled

9.4.5 Thermal motor protection

Description

The priority of thermal motor protection is to identify critical situations. If alarm thresholds are exceeded, the user can set parameterizable response options (p0610) that enable continued operation (e.g. with reduced power) and prevent immediate shutdown.

The signal characteristic is shown in plan 902.

- Effective protection is also possible without a temperature sensor (p4100 = 0). The temperatures of different motor components (stators, core, rotors) can be determined indirectly using a temperature model.
- Connecting temperature sensors (KTY84 or PTC100 to the Customer Terminal Block (TM31) terminal X522:7(+)/8(-)) allows the motor temperature to be determined directly. In this way, accurate start temperatures are available immediately when the motor is switched on again or after a power failure.

Temperature measurement via KTY

The device is connected to terminals X522:7 (anode) and X522:8 (cathode) on the Customer Terminal Block in the forward direction of the diode. The measured temperature is limited to between –48°C and +248°C and is made available for further evaluation.

- Set the KTY temperature sensor type: p4100 = 2
- Activate motor temperature measurement via the external sensor: p0600 = 10
- When the alarm threshold is reached (set via p0604; factory setting: 120°C), alarm A7910 is triggered.
- Parameter p0610 can be used to set how the drive responds to the alarm triggered:
  - 0: No response, only alarm, no reduction of I_max
  - 1: Alarm with reduction of I_max and fault (F7011)
  - 2: Alarm and fault (F7011), no reduction of I_max
- When the fault threshold is reached (set via p0605; factory setting: 155°C), fault F7011 is triggered in conjunction with the setting in p0610.

Temperature measurement via PTC

The device is connected to terminal X522:7/8 on the Customer Terminal Block (TM31). The threshold for switching to an alarm or fault is 1650 Ω. If the threshold is exceeded, the system switches internally from an artificially-generated temperature value of –50°C to +250°C and makes it available for further evaluation.

- Set the KTY temperature sensor type: p4100 = 1
- Activate motor temperature measurement via the external sensor: p0600 = 10
- Alarm A7910 is triggered once the PTC responds.
- Fault F7011 is triggered once the waiting time defined in p0606 has elapsed.

Sensor monitoring for wire breakage/short-circuit

If the temperature of the motor temperature monitor is outside the range –50°C to +250°C, the sensor cable is broken or has short-circuited. Alarm A07915 ("Alarm: temperature sensor fault") is triggered. Fault F07016 (“Fault: temperature sensor fault”) is triggered once the waiting time defined in p0607 has elapsed.

Fault F07016 can be suppressed by p0607 = 0. If an induction motor is connected, the drive continues operating with the data calculated in the thermal motor model.

If the system detects that the motor temperature sensor set in p0600 is not connected, alarm A07820 "Temperature sensor not connected" is triggered.

Function diagram

FD 8016	Thermal monitoring motor
FD 9576	TM31 -temperature evaluation KTY/PTC
FD 9577	TM31 -sensor monitoring KTY/PTC

Parameters

- p0600 Motor temperature sensor for monitoring
- p0604 Motor overtemperature alarm threshold
- p0605 Motor overtemperature fault threshold
- p0606 Motor overtemperature timer
- p0607 Temperature sensor fault timer
- p0610 Response to motor overtemperature condition
- p4100 Temperature evaluation sensor type

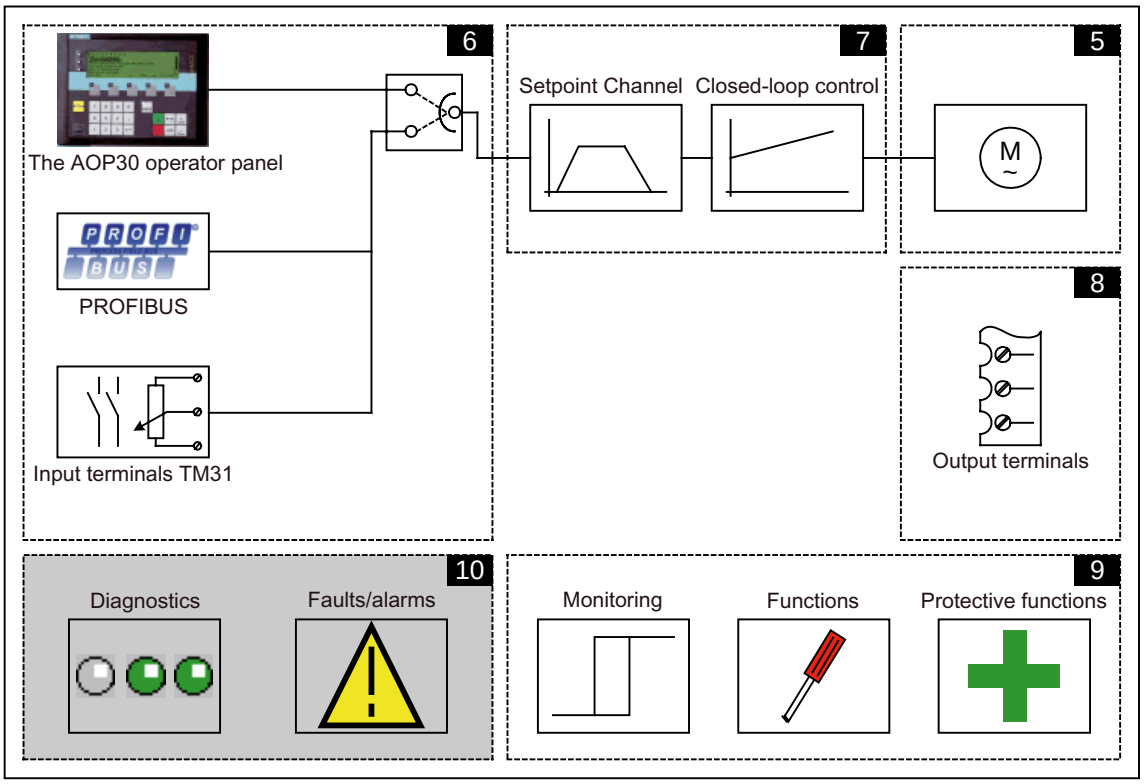
Diagnosis / faults and alarms

10

10.1 Chapter content

This chapter provides information on the following:

- Troubleshooting
- Service and support offered by Siemens AG



10.2 Diagnosis

Description

This section describes procedures for identifying the causes of problems and the measures you need to take to rectify them.

Note

If errors or malfunctions occur in the device, you must carefully check the possible causes and take the necessary steps to rectify them. If you cannot identify the cause of the problem or you discover that components are defective, your regional office or sales office should contact Siemens Service and describe the problem in more detail.

10.2.1 Diagnostics via LEDs

CU320 Control Unit

Table 10-1 Description of the LEDs on the CU320

LED	Color	Status	Description
RDY (ready)	---	OFF	No electronics power supply or electronics power supply is outside permissible tolerance range.
	Green	Continuous	The component is ready to operate and cyclic DRIVE-CLiQ communication is taking place. The Control Unit is awaiting first commissioning.
		2 Hz flashing light	Writing to CompactFlash card.
	Red	Continuous	At least one fault is present in this component.
		0.5 Hz flashing light	CompactFlash Card has not been inserted. Boot error (e.g., firmware cannot be loaded to the RAM).
	Green/red	Flashing light 0.5 Hz	Control Unit 320 is ready to operate. However, there are no software licenses.
	Orange	Continuous	System is booting and DRIVE-CLiQ communication is being established.
		0.5 Hz flashing light	DRIVE-CLiQ component firmware update in progress.
		2 Hz flashing light	Component firmware update complete. Waiting for POWER ON of relevant components.
DP1 (PROFIdrive cyclic transmission)	---	OFF	Cyclic communication is not (yet) taking place. Note: The PROFIdrive is ready for communication when the Control Unit is ready to operate (see RDY LED).
	Green	Continuous	Cyclic communication is taking place.
		0.5 Hz flashing light	Cyclic communication is not fully underway yet. Possible causes: - The controller is not transmitting any setpoints. - In isochronous mode, the controller did not send a Global Control or it sent a defective Global Control (GC).
	Red	Continuous	Cyclic communication has been interrupted.
	Orange	2 Hz flashing light	Firmware checksum error (CRC error).
OPT (option)	---	OFF	Electronics power supply outside permissible tolerance range. The component is not ready to operate. The Option Board is missing or an associated drive object has not been created.
	Green	Continuous	Option board is ready.
		0.5 Hz flashing light	Depends on the option board used.
	Red	Continuous	At least one fault is present in this component. The option board is not ready (e.g., after power ON).
MOD	---	OFF	Reserved

Customer terminal block TM31

Table 10-2 Description of the LEDs on the TM31

LED	Color	Status	Description
RDY	---	OFF	The electronics power supply is missing or lies outside permissible tolerance range.
	Green	On permanently	The component is ready to operate and cyclic DRIVE-CLiQ communication is taking place.
	Orange	On permanently	DRIVE-CLiQ communication is being established.
	Red	On permanently	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.
		2 Hz flashing light	Firmware download is complete. Waiting for POWER ON.
	Green/orange or red/orange	2 Hz flashing light	Detection of the components via LED is activated (p0154). Note: Both options depend on the LED status when module recognition is activated via p0154 = 1.

Control Interface Board in the Power Module

Table 10-3 Description of the LEDs on the Control Interface Board

LED state		Description
H200	H201	
Off	Off	No electronics power supply or electronics power supply is outside permissible tolerance range.
Green	Off	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place.
	Orange	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is present.
	Red	The component is ready for operation and cyclic DRIVE-CLiQ communication is taking place. The DC link voltage is too high.
Orange	Orange	DRIVE-CLiQ communication is being established.
Red	---	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
0.5 Hz flashing light: green/red	---	Firmware is being downloaded.
2 Hz flashing light: green/red	---	Firmware download is complete. Waiting for POWER ON.
2 Hz flashing light: green/orange or red/orange	---	Detection of the components via LED is activated (p0124). Note: Both options depend on the LED status when module recognition is activated via p0124 = 1.

⚠WARNING

Hazardous DC link voltages may be present at any time regardless of the status of the "H201" LED.
The warnings on the components must be observed.

SMC30 – encoder evaluation

Table 10-4 Description of the LEDs on the SMC30

LED	Color	Status	Description
RDY	---	OFF	The electronics power supply is missing or lies outside the permissible tolerance range.
	Green	On permanently	The component is ready to operate and cyclic DRIVE-CLiQ communication is taking place.
	Orange	On permanently	DRIVE-CLiQ communication is being established.
	Red	On permanently	At least one fault is pending on this component. Note: LED is driven irrespective of the corresponding messages being reconfigured.
	Green/red	0.5 Hz flashing light	Firmware is being downloaded.
		2 Hz flashing light	Firmware download is complete. Waiting for POWER ON.
	Green/orange or red/orange	2 Hz flashing light	Detection of the components via LED is activated (p0144). Note: Both options depend on the LED status when module recognition is activated via p0144 = 1.
OUT>5 V	---	OFF	Electronics power supply missing or outside permissible tolerance range. Measuring system supply ≤ 5 V (only when ready to operate).
	Orange	On permanently	Electronics power supply for measuring system present. Measuring system supply > 5 V. Notice: You must ensure that the connected encoder can be operated with a 24 V supply. Operating an encoder designed for a 5 V supply with a 24 V supply can damage the encoder electronics beyond repair.

10.2.2 Diagnostics via parameters

All Objects: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0945	Fault code
	Displays the fault number. Index 0 is the most recent fault (last fault to have occurred).
r0948	Fault time received in milliseconds
	Displays the system runtime in ms at which the fault occurred.
r0949	Fault value
	Displays additional information about the fault. This information is required for detailed fault diagnosis.
r2109	Fault time removed in milliseconds
	Displays the system runtime in ms at which the fault was rectified.
r2123	Alarm time received in milliseconds
	Displays the system runtime in ms at which the alarm occurred.
r2124	Alarm value
	Displays additional information about the alarm. This information is required for detailed alarm diagnosis.
r2125	Alarm time removed in milliseconds
	Displays the system runtime in ms at which the alarm was rectified.

CU320: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	Control Unit status display
	Status display for the Control Unit
r0018	Control Unit firmware version
	Displays the firmware version of the Control Unit. For the display parameters for the firmware version of the other connected components, see the parameter description in the List Manual.
r0721	Digital inputs actual terminal value
	Displays the actual value at the digital input terminals on the CU. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.
r0722	Status of digital inputs (CU)
	Displays the status of the digital inputs on the CU. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r0747	Status of digital outputs (CU)
	Display of the CU digital output status. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r2054	Profibus status
	Displays the status of the Profibus interface.

	Name
r9976[0..7]	System load
	Displays the system load. The individual values (computation load and cyclic load) are measured over short time slices; from these values, the maximum, the minimum and the average value are generated and displayed in the appropriate indices. Further, the degree of memory utilization of the data and program memory is displayed.

Vector: key diagnostic parameters (details in List Manual)

Parameters	Name
	Description
r0002	Operating display
	The value provides information about the current operating status and the conditions necessary to reach the next status.
r0020	Speed setpoint smoothed
	Displays the actual smoothed speed/velocity setpoint at the input of the speed/velocity controller or V/f characteristic (after the interpolator).
r0021	Actual speed smoothed
	Displays the smoothed actual value of the motor speed/velocity.
r0026	DC link voltage smoothed
	Displays the smoothed actual value of the DC link.
r0027	Absolute actual current smoothed
	Displays the smoothed actual value of the current.
r0031	Actual torque smoothed
	Displays the smoothed actual torque.
r0035	Motor temperature
	If r0035 does not equal -200.0 °C, the following applies: • This temperature indicator is valid. • An KTY sensor is connected. • If using an asynchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0). If r0035 equals -200.0 °C, the following applies: • This temperature indicator is invalid (temperature sensor fault). • An PTC sensor is connected. If using a synchronous motor, the thermal motor model is activated (p0600 = 0 or p0601 = 0).
r0037	Power Module temperatures
	Displays the measured temperatures in the Power Module.
r0046	Missing drive enable signals
	Displays missing enable signals that are preventing the closed-loop drive control from being commissioned.
r0049	Motor/encoder data set effective (MDS, EDS)
	Displays the effective motor data set (MDS) and the effective encoder data sets (EDS).
r0050	Command data set effective (CDS)
	Displays the effective command data set (CDS)
r0051	Drive data set (DDS) effective

	Name
	Effective drive data set (DDS) display.
r0206	Rated power module power
	Displays the rated power module power for various load duty cycles.
r0207	Rated power module current
	Displays the rated power module power for various load duty cycles.
r0208	Rated power module line supply voltage
	Displays the rated line supply voltage of the power module.

TM31: key diagnostic parameters (details in List Manual)

Parameters	**Name**
	Description
r0002	TM31 operating display
	Operating display for terminal board 31 (TB31).
r4021	Digital inputs actual terminal value
	Displays the actual value at the digital input terminals on the TM31. This parameter shows the actual value, uninfluenced by simulation mode of the digital inputs.
r4022	Status of digital inputs
	Displays the status of the digital inputs on the TM31. This parameter shows the status of the digital inputs under the influence of simulation mode of the digital inputs.
r4047	Status of digital outputs
	Displays the status of the TM31 digital outputs. Inversion via p4048 is taken into account.

10.2.3 Indicating and rectifying faults

The device features a wide range of functions that protect the drive against damage if a fault occurs (faults and alarms).

Indicating faults and alarms

If a fault occurs, the drive displays the fault and/or alarm on the AOP30 operator panel. Faults are indicated by the red "FAULT" LED and a fault screen is automatically displayed. You can use the F1 Help function to call up information about the cause of the fault and how to remedy it. You can use F5 Ack. to acknowledge a stored fault.

Any alarms are displayed by the yellow flashing "ALARM" LED. The system also displays a note in the status bar providing information on the cause.

Every fault and alarm is entered in the fault/alarm buffer along with time the error occurred. The time stamp refers to the relative system time in milliseconds (r0969).

Activate the "Set date/time - AOP synchronization -> Drive" setting to date- and time-stamp errors on the AOP30.

What is a fault?

A fault is a message from the drive indicating an error or other exceptional (unwanted) status. This could be caused by a fault within the converter or an external fault triggered, for example, from the winding temperature monitor for the induction motor. The faults are displayed and can be reported to a higher-level control system via PROFIdrive. In the factory default setting, the message "converter fault" is also sent to a relay output. Once you have rectified the cause of the fault, you have to acknowledge the fault message.

What is an alarm?

An alarm is the response to a fault condition identified by the drive. It does not result in the drive being switched off and does not have to be acknowledged. Alarms are "self acknowledging", that is, they are reset automatically when the cause of the alarm has been eliminated.

10.3 Service and support

Service and support helpline

If you need help and do not know who to contact, we make sure that you receive all the help you need as quickly as possible.

The helpline ensures that a specialist in your area can provide you with professional support. The helpline (in Germany, for example) is available 24 hours a day, 365 days a year. German and English are spoken.

Tel.: 0180 50 50 111

Online Support

Our round-the-clock, worldwide online support service provides quick and efficient support in five languages. The comprehensive Internet-based information system, which is available round the clock, provides product support, services, and support tools in the shop.

Online support provides a wide range of technical information:

- FAQs, tips and tricks, downloads, current news
- Manual
- Helpful programs and software products
- http://www.siemens.de/automation/service&support

Field service

If your plant is down and you need fast, on-site help, we can provide the specialists with the required expertise wherever you are.

With our comprehensive service network, we offer professional and reliable expertise to get your plant up and running again as quickly as possible.

Experts are available 24 hours a day, 365 days a year.

Tel.: 0180 50 50 444

Of course, we can also arrange special service contracts tailored to your specific requirements. For details, please contact your Siemens office.

Spare parts and repairs

Our global network of regional spare parts warehouses and repair centers enables us to respond quickly and reliably with modern logistics procedures.

During the operational phase of your machinery, we provide a comprehensive repairs and spare parts service to ensure maximum operational reliability. Our service includes expert advice with technical problems, and a wide range of product and system support services tailored to your needs.

For more information about repairs or spare parts, please call the following number (in Germany):

Tel.: 0180 50 50 448

You can call this number outside office hours and at the weekend to contact our emergency spare parts service.

Technical support

We offer technical support in both German and English for deploying products, systems, and solutions in drive and automation technology.

In special cases, help is available from professional, trained, and experienced specialists via teleservice and video conferencing.

Free Contact – providing you with free technical support

- In Europe / Africa
  Tel.: +49 (0)180 50 50 222
  Fax: +49 (0)180 50 50 223
  Internet: http://www.siemens.de/automation/support-request
- in America
  Tel.: +14232622522
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  Tel.: +86 1064 757575
  Fax: +86 1064 747474
  E-mail: adsupport.asia@siemens.com

Maintenance and servicing 11

11.1 Chapter content

This chapter provides information on the following:

- Maintenance and servicing procedures that have to be carried out on a regular basis to ensure the availability of the devices.
- Exchanging device components when the unit is serviced
- Forming the DC link capacitors
- Upgrading the device firmware

⚠DANGER

Before carrying out any maintenance or repair work on the de-energized chassis unit, wait for 5 minutes after switching off the supply voltage. This allows the capacitors to discharge to a harmless level (< 25 V) after the supply voltage has been switched off.

Before starting work, you should also measure the voltage after the 5 minutes have elapsed. The voltage can be measured on DC link terminals DCP and DCN.

11.2 Maintenance

The chassis unit comprises mostly electronic components. Apart from the fan(s), the unit, therefore, contains hardly any components that are subject to wear or that require maintenance or servicing. The purpose of maintenance is to preserve the specified condition of the chassis unit. Dirt and contamination must be removed regularly and parts subject to wear replaced.

The following points must generally be observed.

11.2.1 Cleaning

Dust deposits

Dust deposits inside the chassis unit must be removed at regular intervals (or at least once a year) by qualified personnel in line with the relevant safety regulations. The unit must be cleaned using a brush and vacuum cleaner, and dry compressed air (max. 1 bar) for areas that cannot be easily reached.

Ventilation

When installing the devices in a cabinet, make sure that the cabinet ventilation slots are not obstructed. The fan must be checked to make sure that it is functioning correctly.

Cable and screw terminals

Cable and screw terminals must be checked regularly to ensure that they are secure in position, and if necessary, retightened. Cabling must be checked for defects. Defective parts must be replaced immediately.

Note

The actual intervals at which maintenance procedures are to be performed depend on the installation conditions and the operating conditions.

Siemens offers its customers support in the form of a service contract. For further details, contact your regional office or sales office.

11.3 Maintenance

11.3.1 Maintenance

Servicing involves activities and procedures for maintaining and restoring the operating condition of the device.

Required tools

The following tools are required for replacing components:

- Spanner or socket spanner (w/f 10)
- Spanner or socket spanner (w/f 13)
- Spanner or socket spanner (w/f 16/17)
- Spanner or socket spanner (w/f 18/19)
- Hexagon-socket spanner (size 8)
- Torque wrench up to 50 Nm
- Screwdriver size 1 / 2
- Screwdriver Torx T20
- Screwdriver Torx T30

Tightening torques for current-carrying parts

When securing connections for current-carrying parts (DC link, motor connections, busbars), you must observe the following tightening torques.

Table 11-1 Tightening torques for connecting current-carrying parts

Screw	Torque
M6	6 Nm
M8	13 Nm
M10	25 Nm
M12	50 Nm

11.3.2 Installation device

Description

The installation device is used for installing and removing the power blocks.

It is used as an installation aid, which is placed in front of and secured to the module. The telescopic guide support allows the withdrawable device to be adjusted according to the height at which the power blocks are installed. Once the mechanical and electrical connections have been removed, the power block can be removed from the module, whereby the power block is guided and supported by the guide rails on the withdrawable devices.

Figure 11-1 Installation device

Order number

Order number for the installation device: 6SL3766-1FA00-0AA0.

11.3.3 Using crane lifting lugs to transport power blocks

Crane lifting lugs

The power blocks are fitted with crane lifting lugs for transportation on a lifting harness in the context of replacement.

The positions of the crane lifting lugs are illustrated by arrows in the figures below.

⚠ WARNING
A lifting harness with vertical ropes or chains must be used to prevent any risk of damage to the housing.

CAUTION
The power block busbars must not be used to support or secure lifting harnesses for the purpose of transportation.

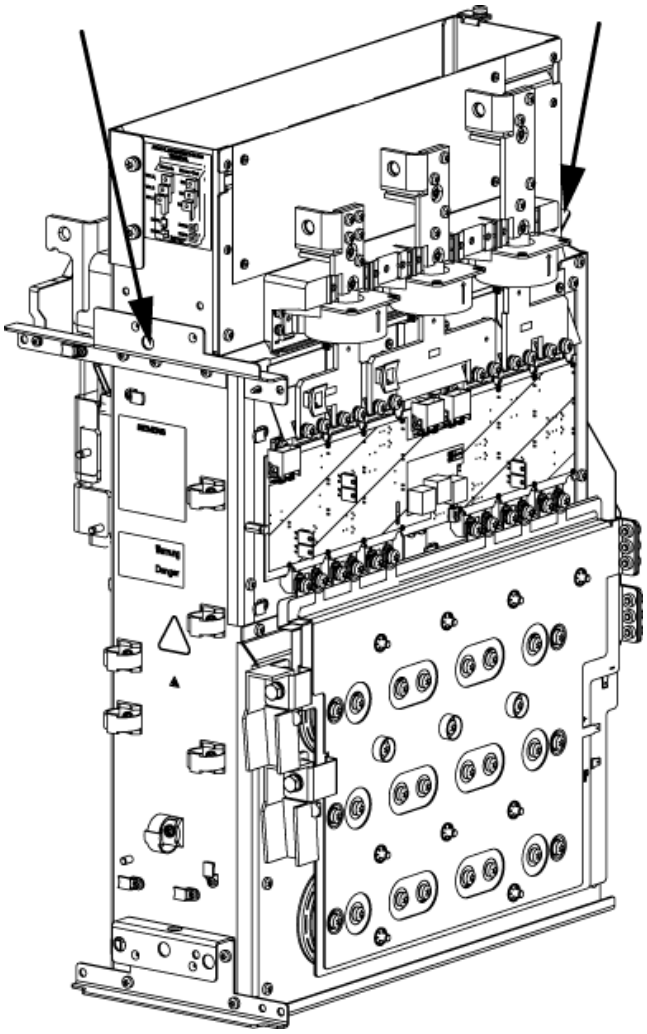

Figure 11-2 Crane lifting lugs on FX, GX power block

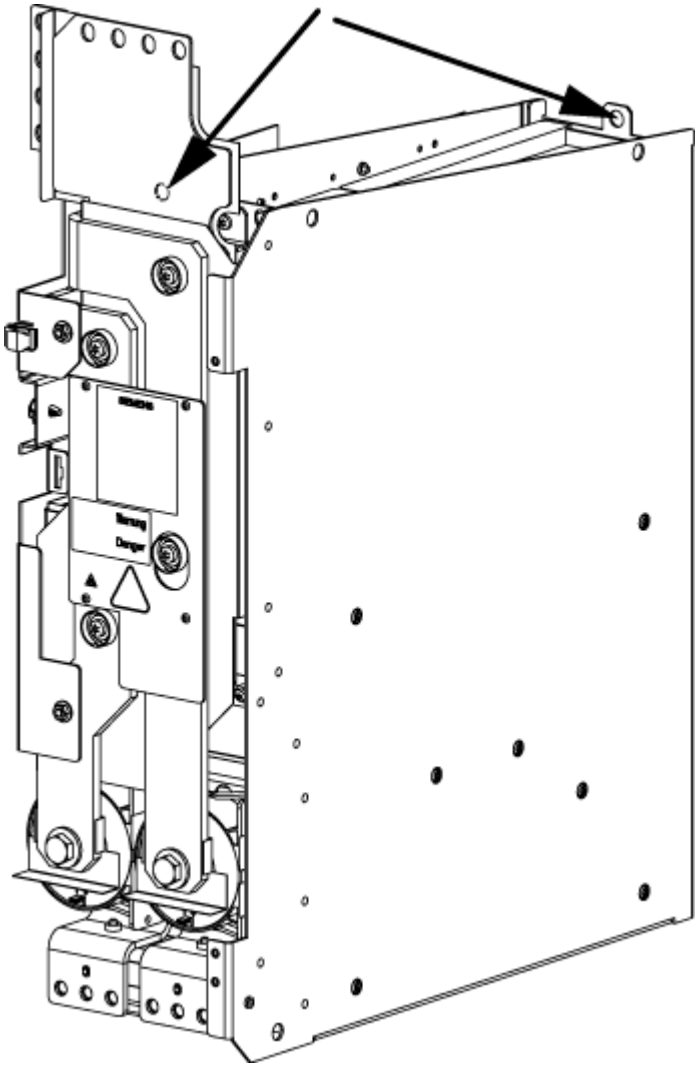

Figure 11-3 Crane lifting lugs on HX, JX power block

Note

On HX and JX power blocks, the front crane lifting lug is located behind the busbar.

11.4 Replacing components

⚠ WARNING

The following must be taken into account when the devices are transported:

- Some of the devices are heavy or top heavy.
- Due to their weight, the devices must be handled with care by trained personnel.
- Serious injury or even death and substantial material damage can occur if the devices are not lifted or transported properly.

⚠ WARNING

The cabinet units are operated with high voltages.

All connection work must be carried out when the cabinet is de-energized!

All work on the device must be carried out by trained personnel only. Non-observance of these warnings can result in death, serious personal injury, or substantial property damage.

Work on an open device must be carried out with extreme caution because external supply voltages may be present. The power and control terminals may be live even when the motor is not running.

Dangerously high voltage levels are still present in the device up to five minutes after it has been disconnected due to the DC link capacitors. For this reason, the cabinet should not be opened until after a reasonable period of time has elapsed.

11.4.1 Replacing the power block, frame size FX

Replacing the power block

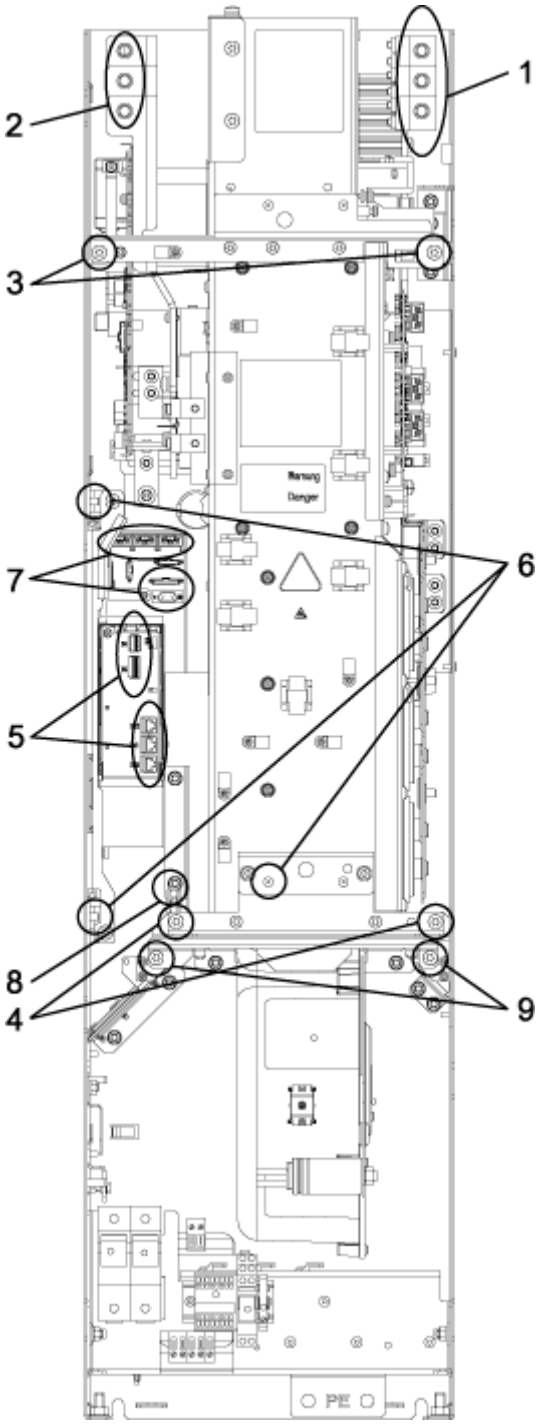

Figure 11-4 Replacing the power block, frame size FX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal steps

The steps for the removal procedure are numbered in accordance with the diagram.

1. Unscrew the connection to the outgoing motor section (3 screws).
2. Unscrew the connection to the line supply (3 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
6. Remove the CU320 mounts (1 screw and 2 nuts). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and remove the CU320.
7. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
8. Disconnect the plug for the thermocouple.
9. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and ensure that they are secure. The screwed union connections for the protective covers must only be tightened by hand.

11.4.2 Replacing the power block (frame size GX)

Replacing the power block

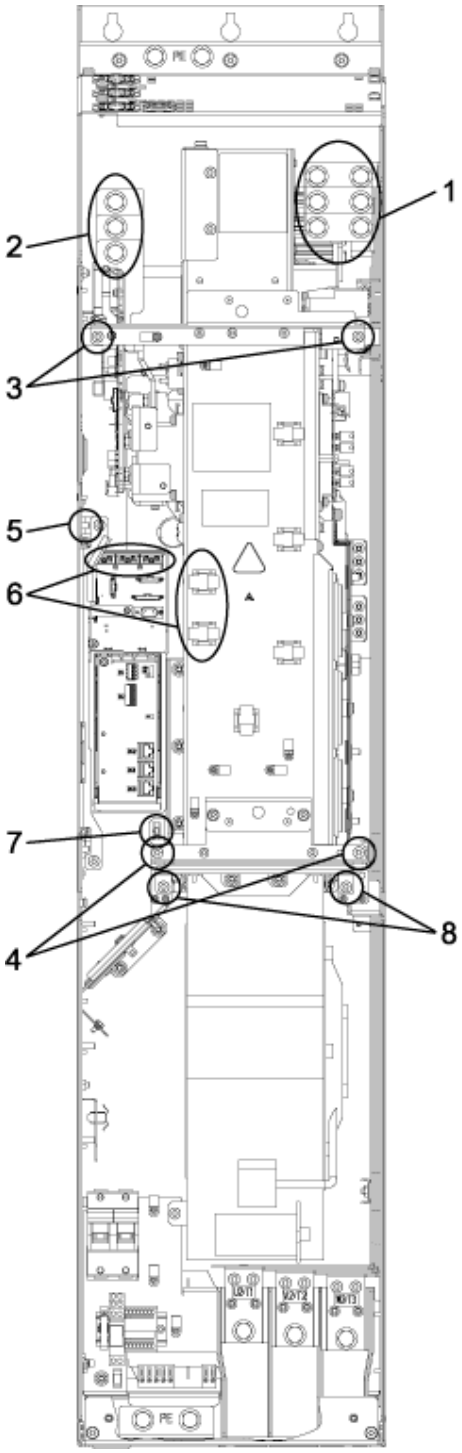

Figure 11-5 Replacing the power block, frame size GX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Unscrew the connection to the outgoing motor section (3 screws).
2. Unscrew the connection to the line supply (3 screws).
3. Remove the retaining screws at the top (2 screws).
4. Remove the retaining screws at the bottom (2 screws).
5. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
6. Disconnect the connectors for the fiber optic cables (5 plugs) and release the cable connection for the signal cables (2 connectors).
7. Disconnect the plug for the thermocouple.
8. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and ensure that they are secure. The screwed union connections for the protective covers must only be tightened by hand.

11.4.3 Replacing the power block (frame size HX)

Replacing the left-hand power block

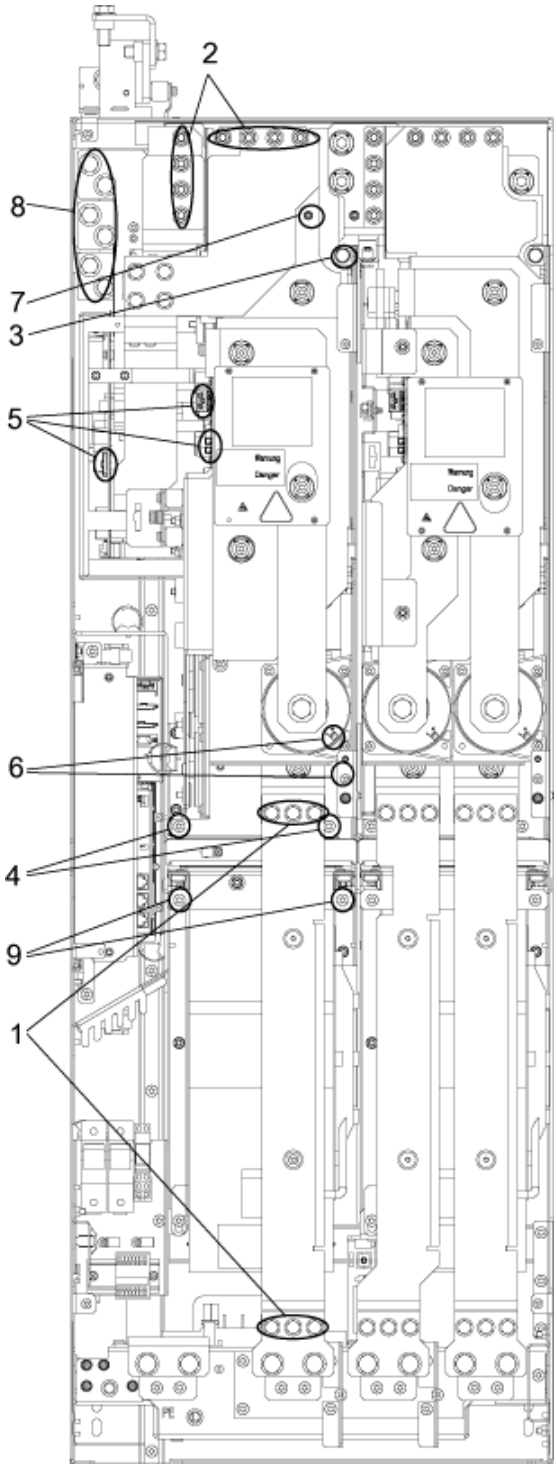

Figure 11-6 Replacing the power block (frame size HX) (left-hand power block)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the busbar (6 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plugs for the fiber optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated PE connection (1 plug).
7. Remove the connection for the DC link sensor (1 nut).
8. Remove the power connections (6 screws).
9. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

Replacing the right-hand power block

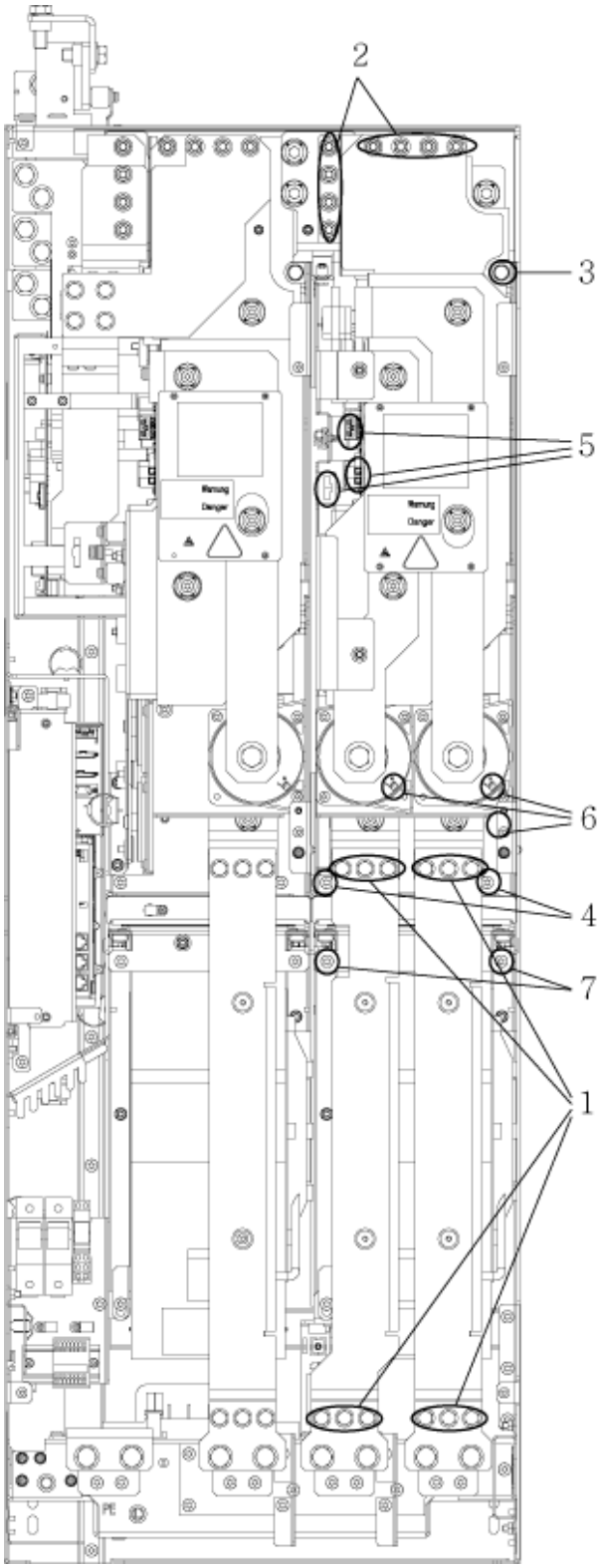

Figure 11-7 Replacing the power block (frame size HX) (right-hand power block)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the busbars (12 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plugs for the fiber optic cables and signal cables (3 plugs).
6. Remove the connection for the current transformer and associated PE connection (2 plugs).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

11.4.4 Replacing the power block (frame size JX)

Replacing the left-hand power block

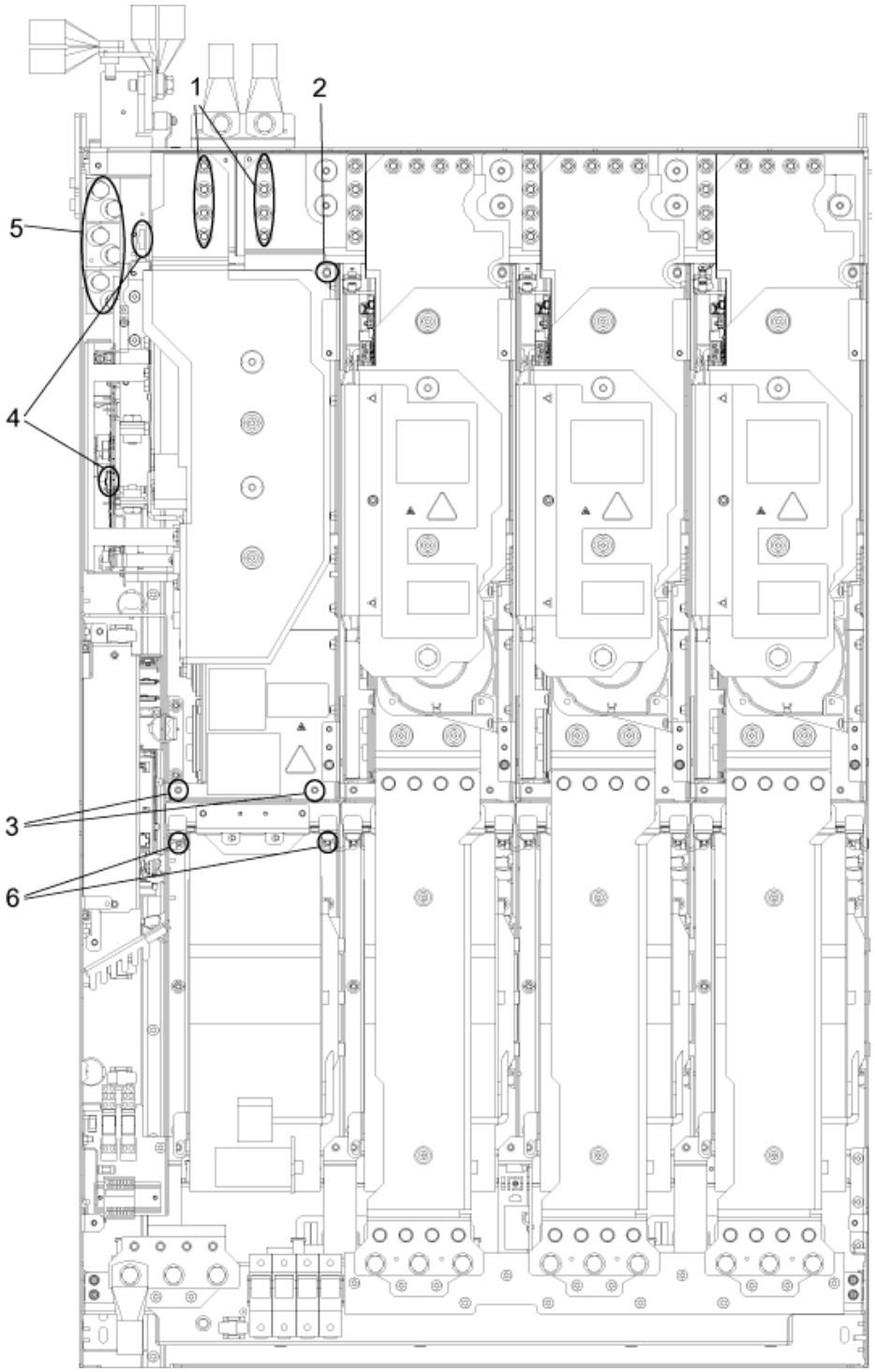

Figure 11-8 Replacing the power block (frame size JX) (left-hand power block)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Unscrew the connection to the DC link (8 nuts).
2. Remove the retaining screw at the top (1 screw).
3. Remove the retaining screws at the bottom (2 screws).
4. Disconnect the plugs for the fiber optic cables and signal cables (2 plugs).
5. Remove the power connections (6 screws).
6. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

Replacing the right-hand power block

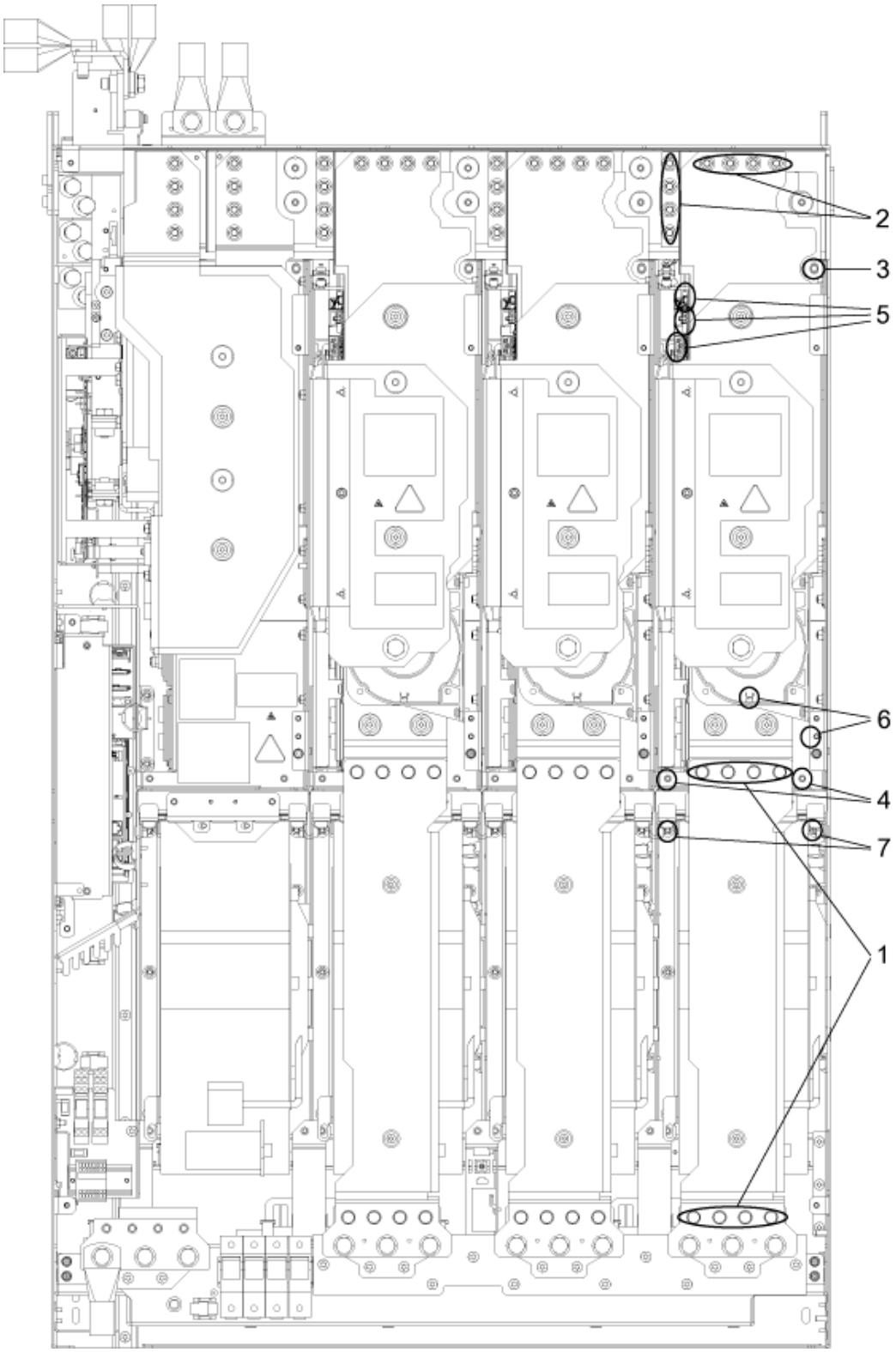

Figure 11-9 Replacing the power block (frame size JX) (right-hand power block)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access to the power block.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the busbar (8 screws).
2. Unscrew the connection to the DC link (8 nuts).
3. Remove the retaining screw at the top (1 screw).
4. Remove the retaining screws at the bottom (2 screws).
5. Disconnect the plugs for the fiber optic cables and signal cables (2 plugs).
6. Remove the connection for the current transformer and associated PE connection (1 plug).
7. Unscrew the two retaining screws for the fan and attach the tool for de-installing the power block at this position.

You can now remove the power block.

CAUTION
When removing the power block, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

11.4.5 Replacing the Control Interface Board, frame size FX

Replacing the Control Interface Board

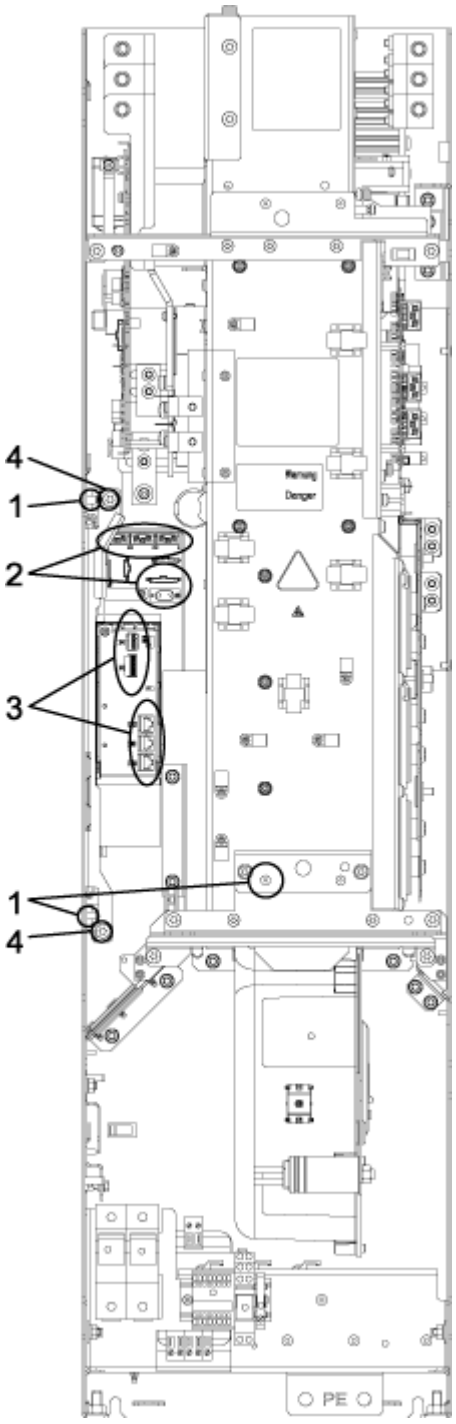

Figure 11-10 Replacing the control interface board, frame size FX

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal steps

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the CU320 mounts (1 screw and 2 nuts). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and remove the CU320.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 below).

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION
When removing the connector of the ribbon cable, make sure that you actuate the locking lever on the connector very carefully (e.g., with a screwdriver) because otherwise the lock could be damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected. The screwed union connections for the protective covers must only be tightened by hand.

11.4.6 Replacing the Control Interface Board, frame size GX

Replacing the Control Interface Board

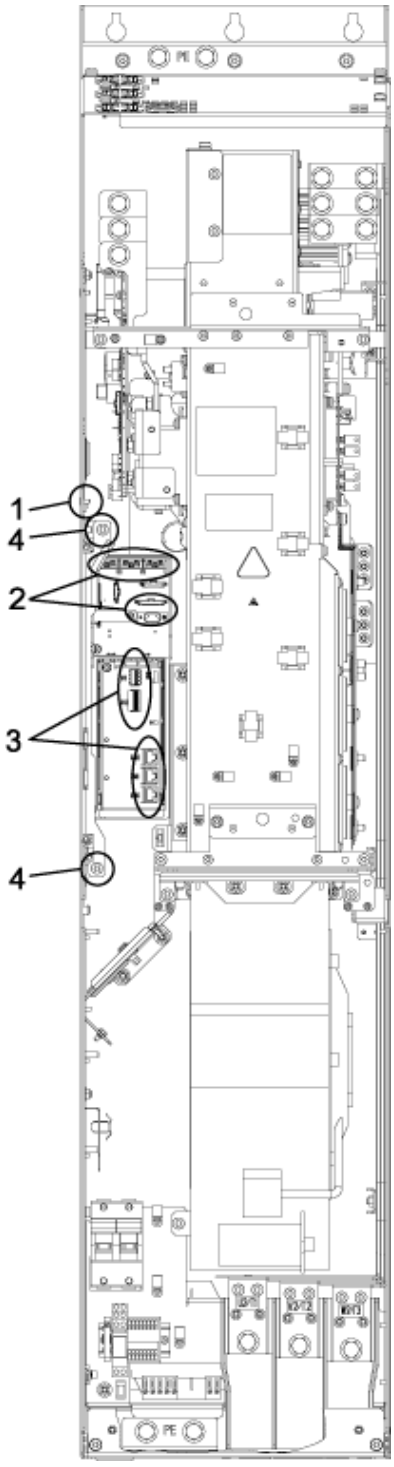

Figure 11-11 Replacing the Control Interface Board (frame size GX)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 at the bottom).

CAUTION
When removing the electronics unit, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION
When removing the connector of the ribbon cable, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) otherwise the lock could be damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected. The screwed connections for the protective covers must only be tightened by hand.

11.4.7 Replacing the Control Interface Board (frame size HX)

Replacing the Control Interface Board

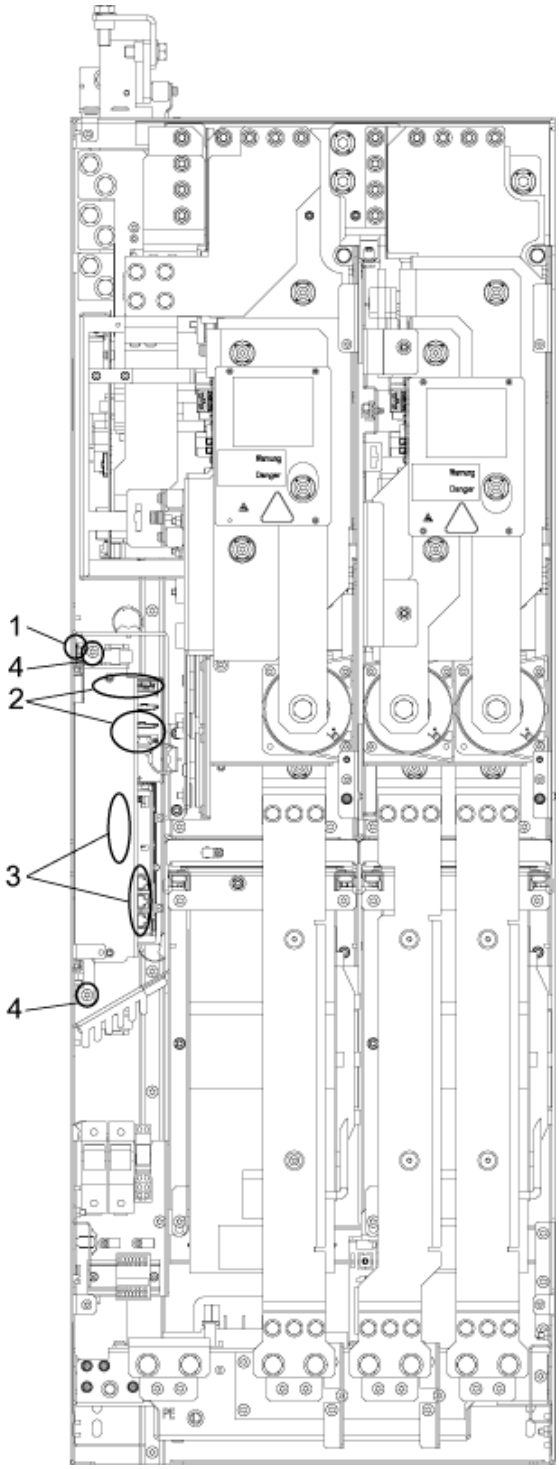

Figure 11-12 Replacing the Control Interface Board (frame size HX)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 at the bottom).

CAUTION
When removing the electronics unit, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION
When removing the connector of the ribbon cable, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) otherwise the lock could be damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected. The screwed connections for the protective covers must only be tightened by hand.

11.4.8 Replacing the Control Interface Board (frame size JX)

Replacing the Control Interface Board

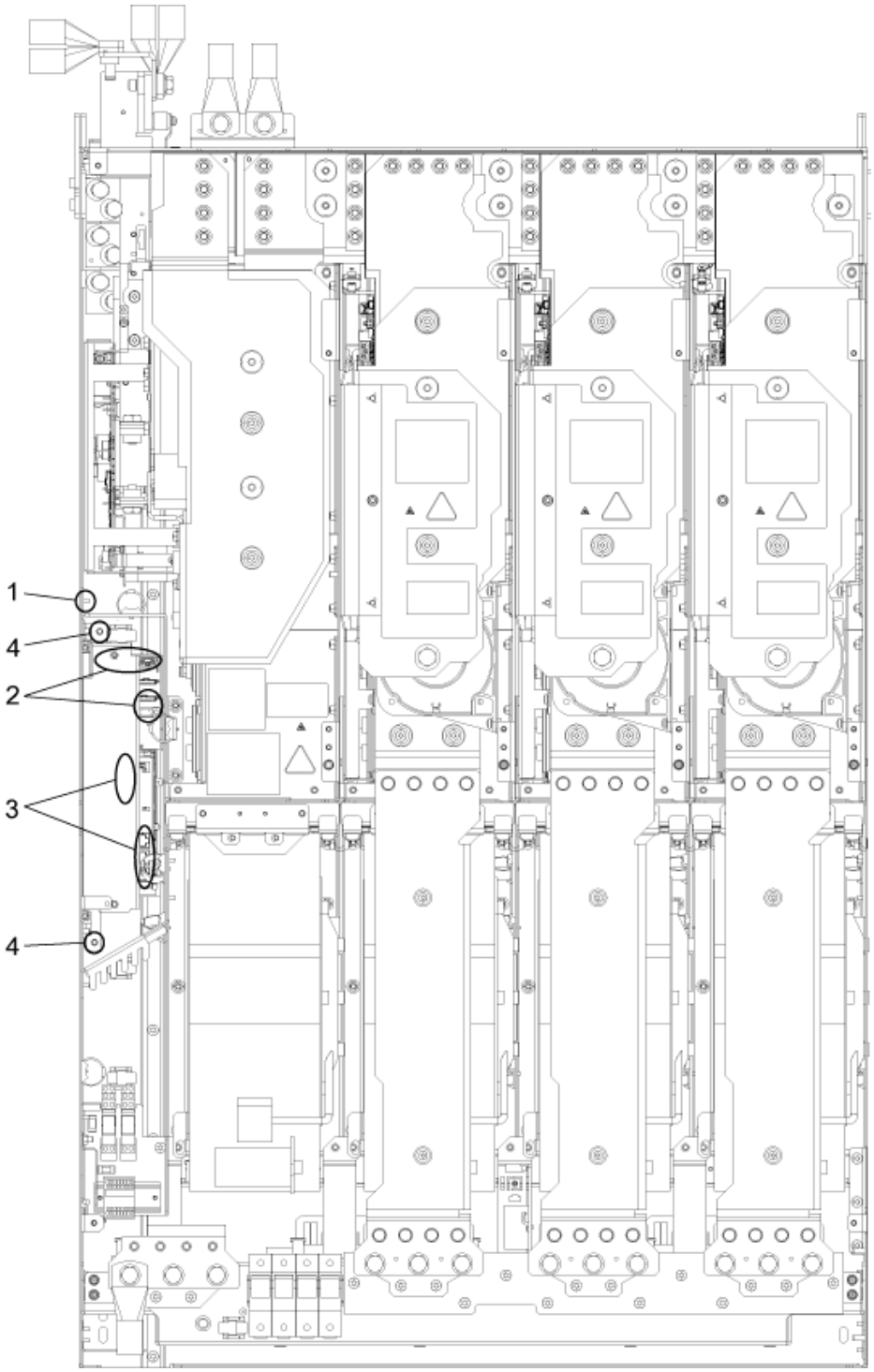

Figure 11-13 Replacing the Control Interface Board (frame size JX)

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the CU320 mount (1 nut). If necessary, remove the PROFIBUS plug and connection to the operator panel (-X140 on the CU320) and carefully remove the CU320.
2. Disconnect the plugs for the fiber optic cables and signal cables (5 plugs).
3. Remove the DRIVE-CLiQ cables and connections to the CU320 (5 plugs).
4. Remove the retaining screws for the slide-in electronics unit (2 screws).
   When removing the slide-in electronics unit, you have to disconnect 5 further plugs one after the other (2 at the top, 3 at the bottom).

CAUTION
When removing the electronics unit, ensure that you do not damage any signal cables.

The Control Interface Board can then be removed from the slide-in electronics unit.

CAUTION
When removing the connector of the ribbon cable, make sure that you actuate the locking lever on the connector very carefully (e.g. with a screwdriver) otherwise the lock could be damaged.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. When dealing with connectors with a lock, make sure that the locking lever is securely engaged once connected. The screwed connections for the protective covers must only be tightened by hand.

11.4.9 Replacing the fan, frame size FX

Replacing the fan

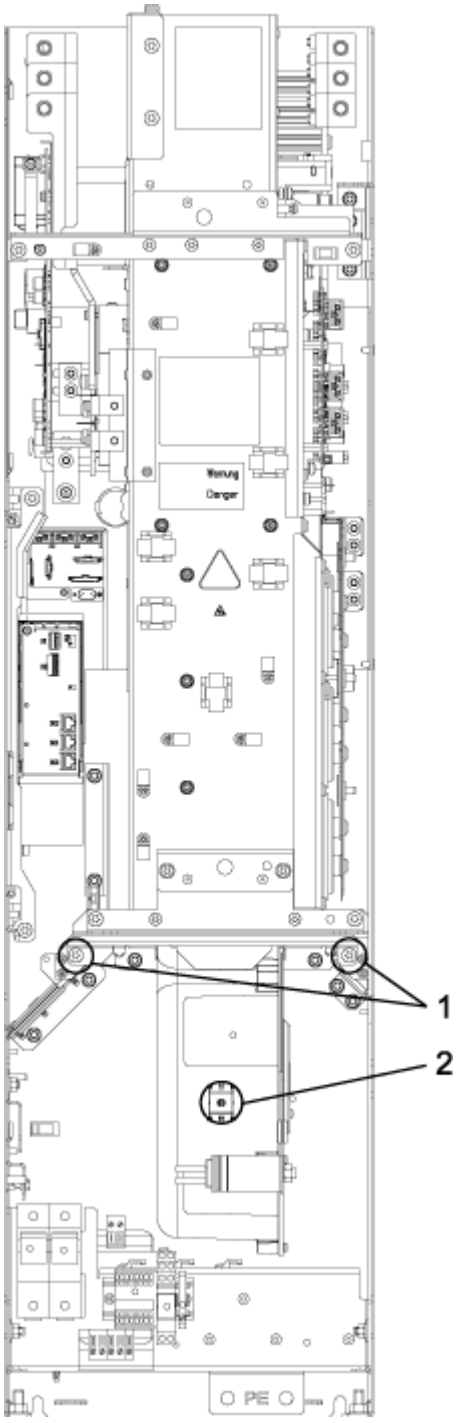

Figure 11-14 Replacing the fan, frame size FX

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g., ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the cabinet unit is available.

Preparatory steps

- Disconnect the built-in unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (2 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation steps

For installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-conducting parts" must be observed. Carefully establish the plug connections and ensure that they are secure. The screwed union connections for the protective covers must only be tightened by hand.

11.4.10 Replacing the fan (frame size GX)

Replacing the fan

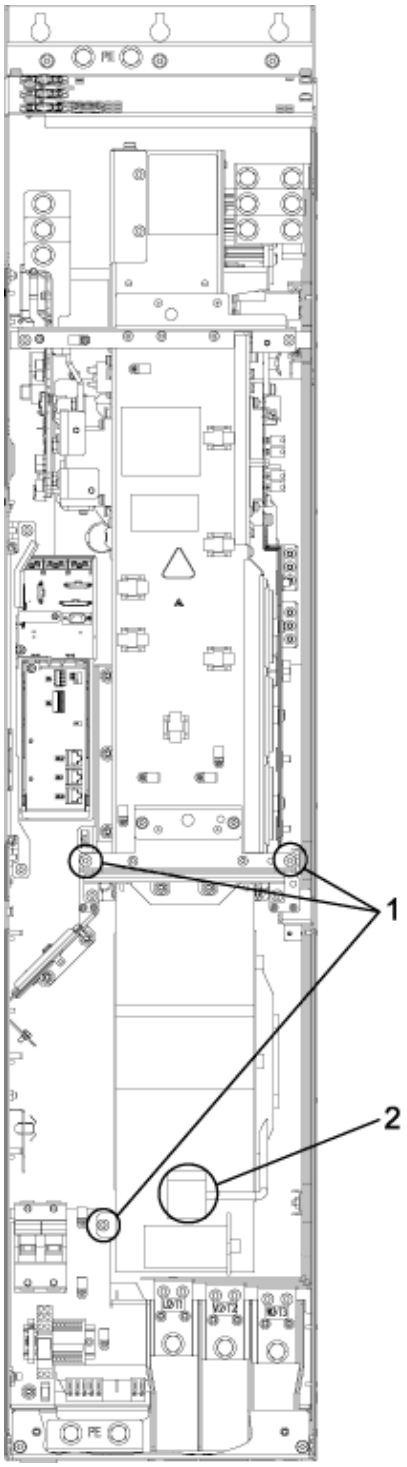

Figure 11-15 Replacing the fan (frame size GX)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the chassis unit is available.

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the retaining screws for the fan (3 screws).
2. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

11.4.11 Replacing the fan (frame size HX)

Replacing the fan (left-hand power block)

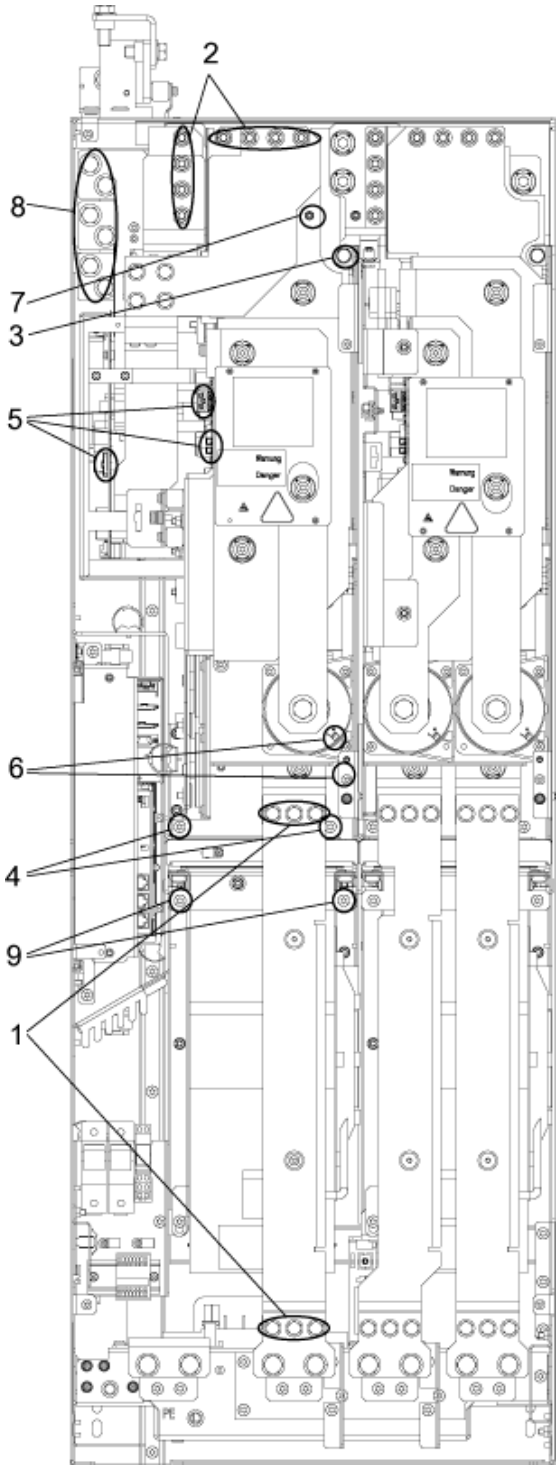

Figure 11-16 Replacing the fan (frame size HX) (left-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the chassis unit is available.

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the copper bar (6 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

Replacing the fan (right-hand power block)

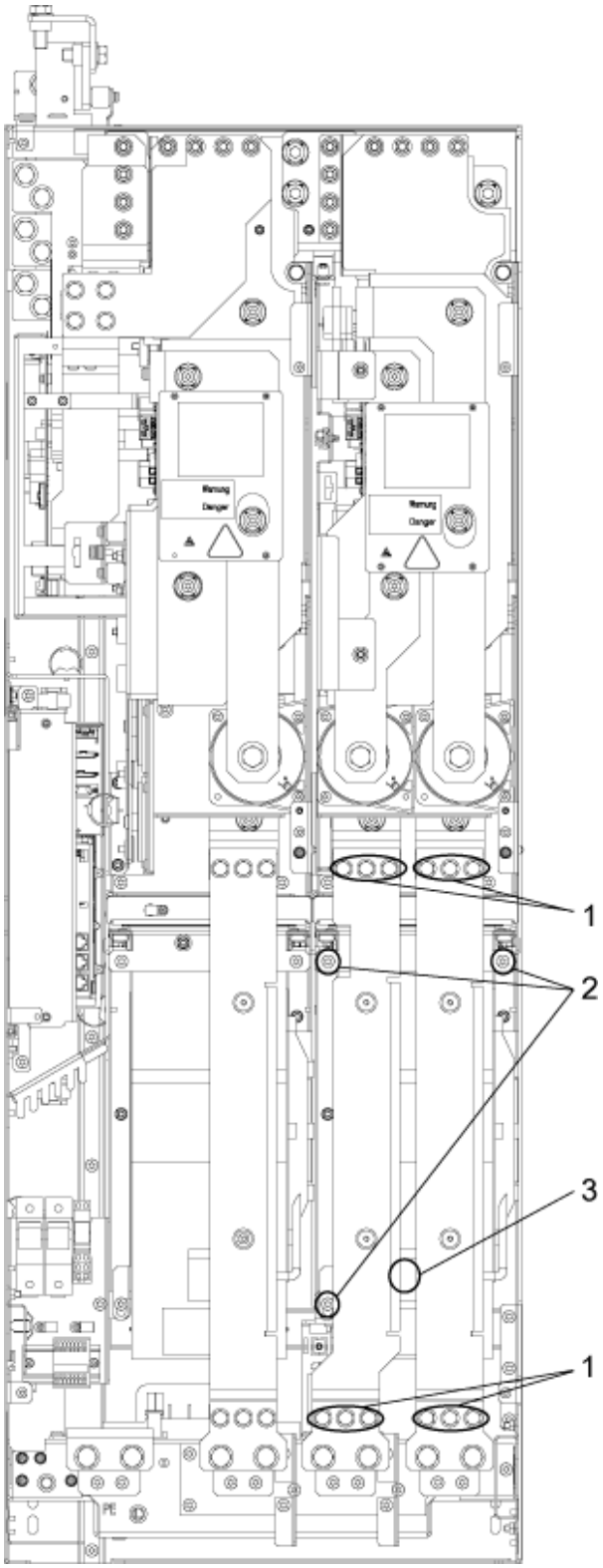

Figure 11-17 Replacing the fan (frame size HX) (right-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the chassis unit is available.

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the copper bar (12 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

11.4.12 Replacing the fan (frame size JX)

Replacing the fan (left-hand power block)

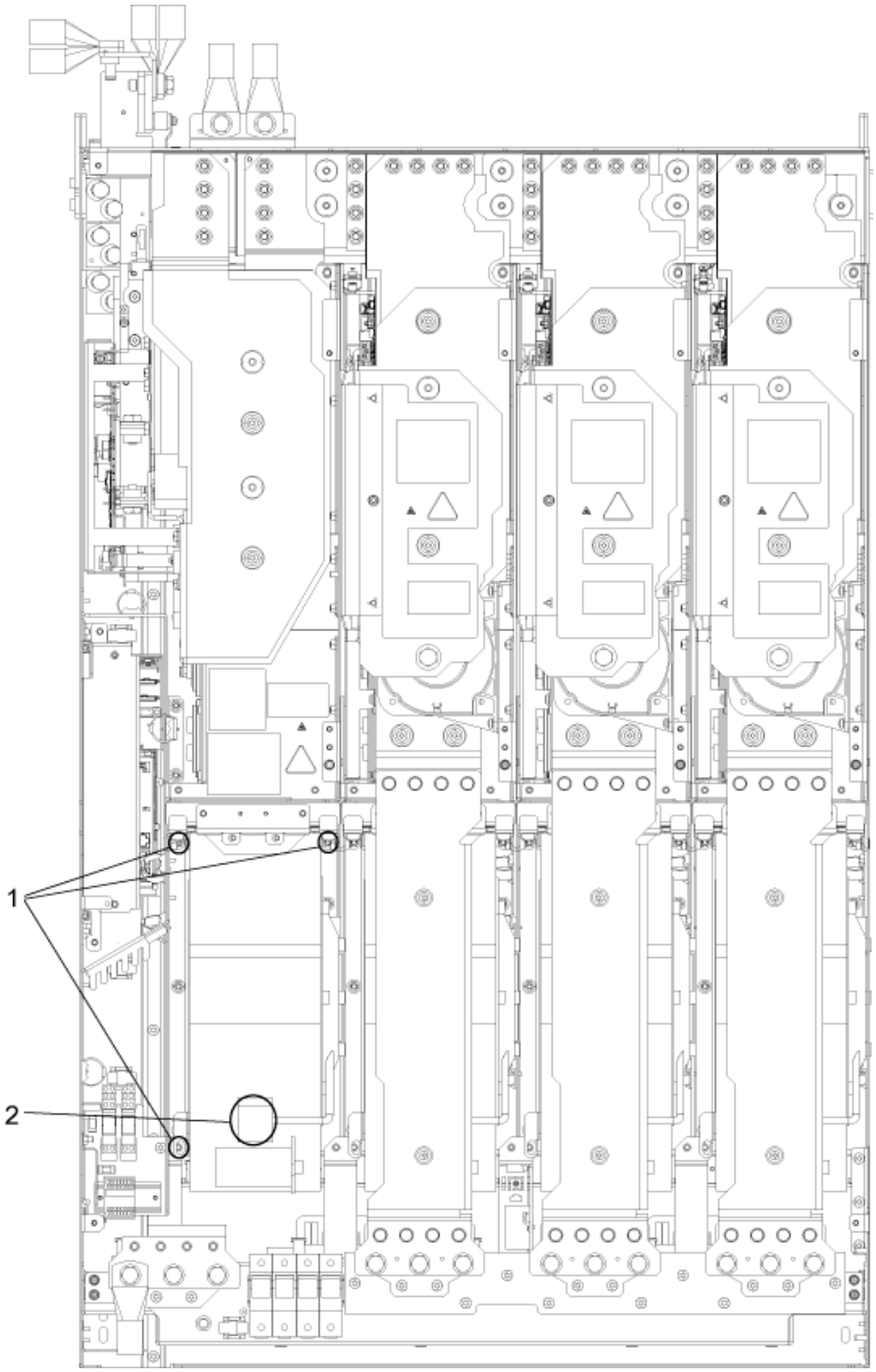

Figure 11-18 Replacing the fan (frame size JX) (left-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the chassis unit is available.

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the copper bar (6 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

Replacing the fan (right-hand power block)

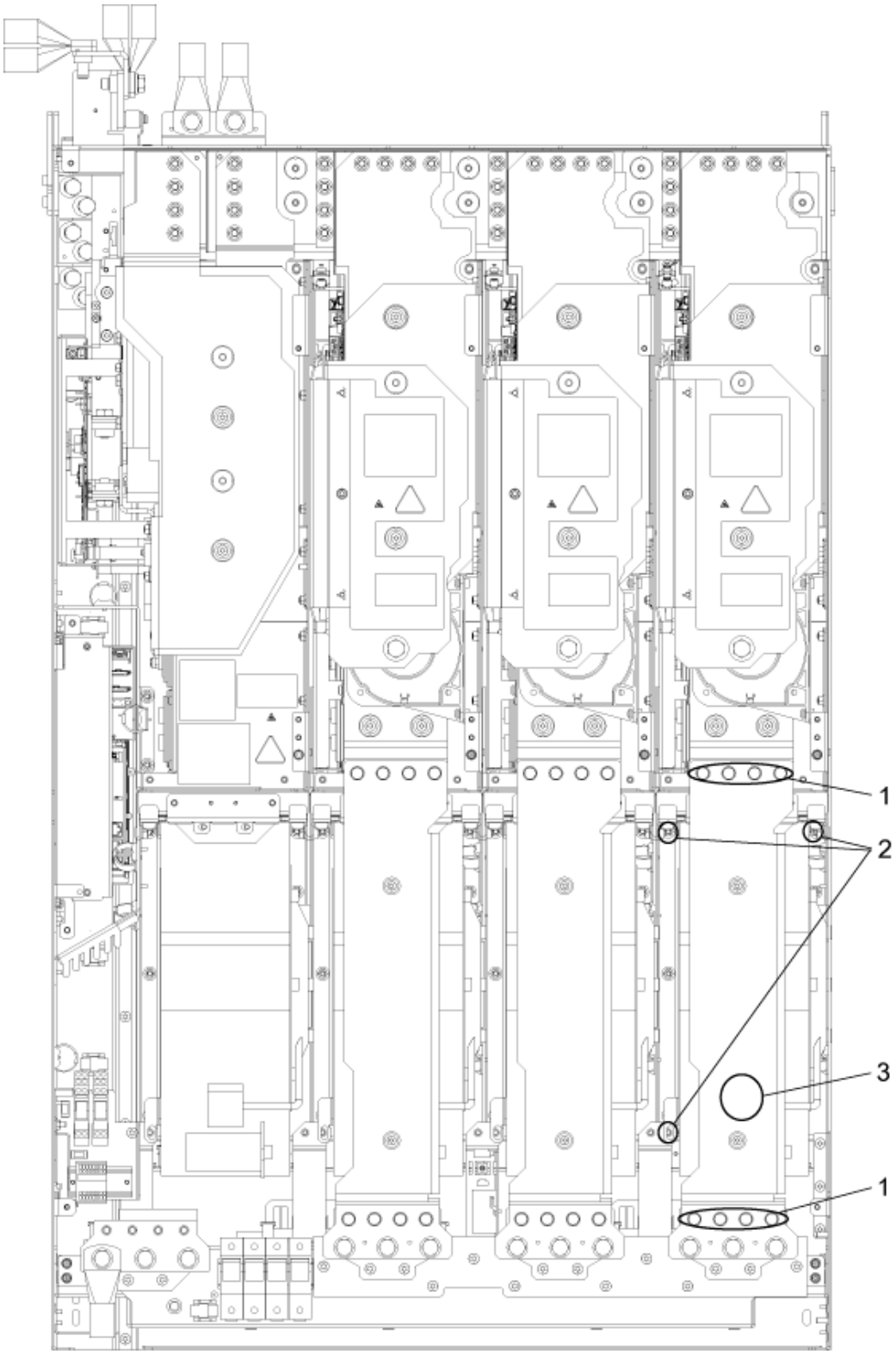

Figure 11-19 Replacing the fan (frame size JX) (right-hand power block)

Description

The average service life of the device fans is 50,000 hours. In practice, however, the service life depends on other variables (e.g. ambient temperature, degree of cabinet protection, etc.) and, therefore, may deviate from this value.

The fans must be replaced in good time to ensure that the chassis unit is available.

Preparatory steps

- Disconnect the chassis unit from the power supply.
- Allow unimpeded access.
- Remove the protective cover.

Removal

The steps for the removal procedure are numbered in accordance with the diagram.

1. Remove the copper bar (8 screws).
2. Remove the retaining screws for the fan (3 screws).
3. Disconnect the supply cables (1 x "L", 1 x "N").

You can now carefully remove the fan.

CAUTION
When removing the fan, ensure that you do not damage any signal cables.

Installation

For re-installation, carry out the above steps in reverse order.

CAUTION
The tightening torques specified in the table "Tightening torques for connecting current-carrying parts" must be observed. Carefully re-establish the plug connections and ensure that they are secure. The screwed connections for the protective covers must only be tightened by hand.

11.5 Forming the DC link capacitors

Description

If the device is kept in storage for more than 2 years, the DC link capacitors have to be reformed. If this is not carried out, the cabinet may be damaged when the supply voltage is switched on.

If the cabinet is commissioned within two years of its date of manufacture, the DC link capacitors do not need to be reformed. The date of manufacture is indicated in the serial number on the type plate (see "Device Overview").

Note

It is important that the storage period is calculated from the date of manufacture and not from the date that the equipment was shipped.

Procedure

The DC link capacitors are re-formed by applying the rated voltage without load for at least 30 minutes at room temperature.

- Operation via PROFIBUS:
  - Set bit 3 of control word 1 (operation enable) permanently to "0".
  - Switch on the converter by means of an ON signal (bit 0 of the control word); all the other bits must be set in such a way that the converter can be operated.
  - Once the waiting time has elapsed, switch off the converter and restore the original PROFIBUS setting.
- Operation via terminal block:
  - Set p0852 to "0" (factory setting is "1").
  - Switch on the converter (via digital input 0 on the customer terminal block).
  - Once the waiting time has elapsed, switch off the converter and restore the original setting for p0852.

Note

Reforming cannot be carried out in LOCAL mode via the AOP30.

11.6 Messages after replacing DRIVE-CLiQ components

After DRIVE-CLiQ components are replaced (Control Interface Board, TM31, SMCxx) when service is required, generally, after power-up, a message is not output.

The reason for this is that an identical component is detected and accepted as spare part when running-up. If, unexpectedly, a fault message of the "topology fault" category is displayed, then when replacing a component, one of the following faults/errors should have occurred:

- A Control Interface Board with different firmware data was installed.
- When connecting-up DRIVE-CLiQ cables, connections were interchanged.

Automatic firmware update

As of firmware 2.5, an automatic firmware update can be carried out once the electronics have been powered up on replacement DRIVE-CLiQ components.

- The following LEDs will flash slowly to indicate that an automatic firmware update is in progress: the "RDY" LED on the Control Unit (orange, 0.5 Hz) and an LED on the relevant DRIVE-CLiQ component (green-red, 0.5 Hz).
- Once the automatic firmware update is complete, the "RDY" LED on the Control Unit will flash quickly (orange, 2 Hz) along with an LED on the relevant DRIVE-CLiQ component (green-red, 2 Hz).
- To complete the automatic firmware update process, a POWER ON is required (switch the device off and back on again).

11.7 Upgrading the chassis unit firmware

When you upgrade the built-in unit firmware (by installing a new CompactFlash Card with a new firmware version, for example), you might also have to upgrade the firmware for the DRIVE-CLiQ components in the built-in unit.

If the system detects that the firmware in the DRIVE-CLiQ components needs to be updated, it will trigger this process automatically when the automatic firmware update is performed.

Automatic firmware update sequence

1. During an automatic firmware update, the "RDY" LED on the CU320 Control Unit flashes slowly (orange, 0.5 Hz).
2. The firmware update is performed automatically and in sequence on the DRIVE-CLiQ components; during the update process, an LED on the component whose firmware is being updated will flash slowly (green/red, 0.5 Hz).
3. Once the firmware update on an individual DRIVE-CLiQ component is complete, the LED on that component will flash quickly (green/red, 2 Hz).
4. Once the firmware update on all components is complete, the LED on the CU320 Control Unit will flash quickly (orange, 2 Hz).
5. To complete the automatic firmware update process, a POWER ON is required (switch the unit off and back on again).

Note

The power supply to the components must not be interrupted while the firmware is being upgraded.

CAUTION
New firmware should only be installed if there is a problem with the unit. Problems with the unit cannot be ruled out after the firmware has been upgraded.

12 Technical specifications

12.1 Chapter content

This chapter provides information on the following:

- General and specific technical specifications for the devices.
- Information on restrictions that apply when the devices are used in unfavorable ambient conditions (derating)

12.2 General specifications

Table 12-1 General technical specifications

Electrical data			
Line frequency	47 Hz to 63 Hz		
Output frequency	0 Hz to 300 Hz		
Line power factor total fundamental factor	≥ 0.98 0.93 to 0.96		
Converter efficiency	> 98%		
Switching at input	Once every 3 minutes		
Mechanical data			
Degree of protection	IP20 (frame sizes FX and GX) IP00 (frame sizes HX and JX)		
Class of protection	To EN 50178, Part 1		
Cooling method	Forced air cooling		
Sound pressure level	≤ 73 dB(A) at 50 Hz line frequency ≤ 75 dB(A) at 60 Hz line frequency		
Touch protection	BGV A 3		
Compliance with standards			
Standards	EN 60 146-1, EN 61 800-2, EN 61 800-3, EN 50 178, EN 60 204-1, EN 60 529		
CE mark	To EMC directive No. 89/336/EC and low voltage directive No. 73/23/EC		
EMC conformance	In accordance with EMC product standard for variable-speed drives EN 61 800-3, category C3 (optional category C2) [1]		
Approval	cULus (File No.: E192450) (only up to 600 V 3 AC)		
Ambient conditions			
	Operation	Storage	Transport
Ambient temperature	0°C to +40°C up to + 50°C with derating	-25°C to +55°C	-25°C to +70°C as of –40°C for 24 hours
Relative humidity (non-condensing), corresponds to class	5% to 95% 3K3 to IEC 60 721-3-3	5% to 95% 1K4 to IEC 60 721-3-1	5% to 95% at 40°C 2K3 to IEC 60 721-3-2
Installation altitude	Up to 2000 m above sea level without derating, > 2000 m above sea level with derating (see "Derating data")		
Mechanical stability			
Vibrational load: - Displacement - Acceleration	0.075 mm at 10 Hz to 58 Hz 10 m/s² at > 58 Hz to 200 Hz	1.5 mm at 5 Hz to 9 Hz 5 m/s² at > 9 Hz to 200 Hz	3.1 mm at 5 Hz to 9 Hz 10 m/s² at > 9 Hz to 200 Hz
Shock load: - Acceleration	100 m/s² at 11 ms	40 m/s² at 22 ms	100 m/s² at 11 ms

[1] Applies to cable lengths of up to 100 m.

12.2.1 Derating data

Current derating as a function of the site altitude and ambient temperature

If the cabinet units are operated at a site altitude >2000 m above sea level, the maximum permissible output current can be calculated using the following tables. The site altitude and ambient temperature are compensated here.

Table 12-2 Current derating as a function of the ambient temperature and site altitude

Site altitude above sea level in m	Ambient temperature in °C						
	20	25	30	35	40	45	50
0 to 2000	100%					95.0%	87.0%
Up to 2500	100%				96.3%	91.4%	83.7%
Up to 3000	100%			96.2%	92.5%	87.9%	80.5%
Up to 3500	100%		96.7%	92.3%	88.8%	84.3%	77.3%
Up to 4000	100%	97.8%	92.7%	88.4%	85.0%	80.8%	74.0%

Voltage derating as a function of the site altitude

In addition to current derating, voltage derating must also be considered at site altitudes >2000 m above sea level.

Table 12-3 Voltage derating as a function of the site altitude (380 V – 480 V 3 AC)

Site altitude above sea level in m	Rated converter input voltage					
	380 V	400 V	420 V	440 V	460 V	480 V
0 to 2000	100 %					
to 2250	100 %					96 %
to 2500	100 %				98 %	94 %
to 2750	100 %			98 %	94 %	90 %
to 3000	100 %			95 %	91 %	88 %
to 3250	100 %		97 %	93 %	89 %	85 %
to 3500	100 %	98 %	93 %	89 %	85 %	82 %
to 3750	100 %	95 %	91 %	87 %	83 %	79 %
to 4000	96 %	92 %	87 %	83 %	80 %	76 %

Table 12-4 Voltage derating as a function of the site altitude (500 V – 600 V 3 AC)

Site altitude above sea level in m	Rated converter input voltage			
	500 V	525 V	575 V	600 V
0 to 2000	100 %			
to 2250	100 %			
to 2500	100 %			
to 2750	100 %			
to 3000	100 %			
to 3250	100 %			98 %
to 3500	100 %		98 %	94 %
to 3750	100 %		94 %	91 %
to 4000	100 %		91 %	87 %

Table 12-5 Voltage derating as a function of the site altitude (660 V – 690 V 3 AC)

Site altitude above sea level in m	Rated converter input voltage	
	660 V	690 V
0 to 2000	100 %	
to 2250	100 %	96 %
to 2500	98 %	94 %
to 2750	94 %	90 %
to 3000	91 %	88 %
to 3250	89 %	85 %
to 3500	85 %	82 %
to 3750	-	-
to 4000	-	-

Current derating as a function of the pulse frequency

When the pulse frequency is increased, the derating factor of the output current must be taken into account. This derating factor must be applied to the currents specified in the technical specifications.

Table 12-6 Derating factor of the output current as a function of the pulse frequency for devices with a rated pulse frequency of 2 kHz

Order number 6SL3310-...	Power [kW]	Output current at 2 kHz [A]	Derating factor at 4 kHz
Supply voltage 380 – 480 V 3 AC			
1GE32-1AA0	110	210	82%
1GE32-6AA0	132	260	83%
1GE33-1AA0	160	310	88%
1GE33-8AA0	200	380	87%
1GE35-0AA0	250	490	78%

Table 12-7 Derating factor of the output current as a function of the pulse frequency for units with a rated pulse frequency of 1.25 kHz

Order number 6SL3310-...	Power [kW]	Output current at 1.25 kHz [A]	Derating factor at 2.5 kHz	Derating factor at 5 kHz
Supply voltage 380 – 480 V 3 AC				
1GE36-1AA0	315	605	72%	60%
1GE37-5AA0	400	745	72%	60%
1GE38-4AA0	450	840	79%	60%
1GE41-0AA0	560	985	87%	60%
Supply voltage 500 – 600 V 3 AC				
1GF31-8AA0	110	175	87%	60%
1GF32-2AA0	132	215	87%	60%
1GF32-6AA0	160	260	88%	60%
1GF33-3AA0	200	330	82%	55%
1GF34-1AA0	250	410	82%	55%
1GF34-7AA0	315	465	87%	55%
1GF35-8AA0	400	575	85%	55%
1GF37-4AA0	500	735	79%	55%
1GF38-1AA0	560	810	72%	55%

Order number 6SL3310-...	Power [kW]	Output current at 1.25 kHz [A]	Derating factor at 2.5 kHz	Derating factor at 5 kHz
Supply voltage 660 – 690 V 3 AC				
1GH28-5AA0	75	85	89%	60%
1GH31-0AA0	90	100	88%	60%
1GH31-2AA0	110	120	88%	60%
1GH31-5AA0	132	150	84%	55%
1GH31-8AA0	160	175	87%	60%
1GH32-2AA0	200	215	87%	60%
1GH32-6AA0	250	260	88%	60%
1GH33-3AA0	315	330	82%	55%
1GH34-1AA0	400	410	82%	55%
1GH34-7AA0	450	465	87%	55%
1GH35-8AA0	560	575	85%	55%
1GH37-4AA0	710	735	79%	55%
1GH38-1AA0	800	810	72%	55%

For pulse frequencies in the range between the fixed values, the relevant derating factors can be determined by means of linear interpolation.

The following formula applies for this: $$Y_2 = Y_0 + \frac{Y_1 - Y_0}{X_1 - X_0}(X_2 - X_0)$$

Example:
The derating factor is required for when X_2 = 2 kHz for 6SL3730-1GE41-0AA0.

X_0 = 1.25 kHz, Y_0 = 100%, X_1 = 2.5 kHz, Y_1 = 87%, X_2 = 2 kHz, Y_2 = ??

$$Y_2 = 100\ \% + \frac{87\ \% - 100\ \%}{2.5\ \text{kHz} - 1.25\ \text{kHz}}(2\ \text{kHz} - 1.25\ \text{kHz}) =$$

$$100\ \% + \frac{-13\ \%}{1.25\ \text{kHz}}(0.75\ \text{kHz}) = 100\ \% - 7.8\ \% = \underline{\underline{92.2\ \%}}$$

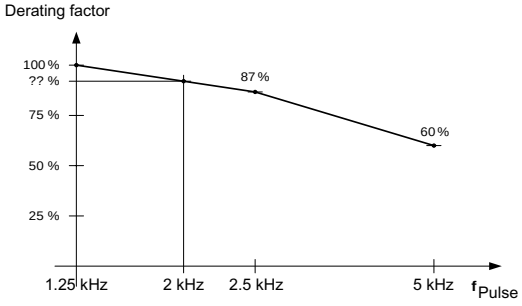

Figure 12-1 Calculating derating factors by means of linear interpolation

12.2.2 Overload capability

The converter is equipped with an overload reserve to deal with breakaway torques, for example.

In drives with overload requirements, the appropriate base load current must, therefore, be used as a basis for the required load.

The criterion for overload is that the drive is operated with its base load current before and after the overload occurs (a load duration of 300 s is used as a basis here).

Low overload

The base load current for low overload (I_L) is based on a load duty cycle of 110% for 60 s or 150% for 10 s.

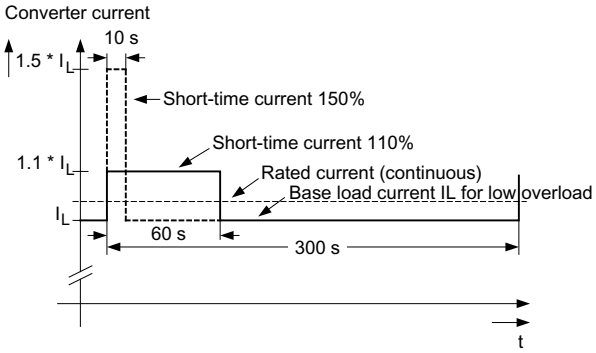

Figure 12-2 Low overload

High overload

The base load current for a high overload I_H is based on a duty cycle of 150% for 60 s or 160% for 10 s.

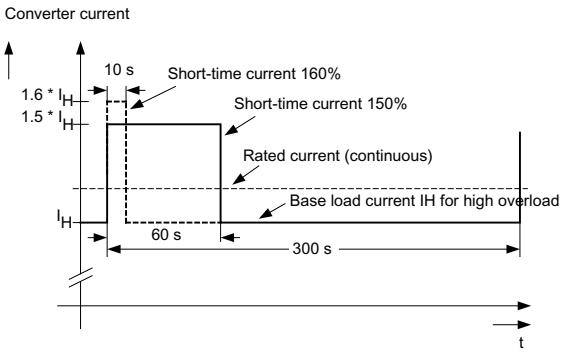

Figure 12-3 High overload

12.3 Technical specifications

Note

The current, voltage and output values specified in the following tables are rated values.
The cables to the cabinet unit are protected by fuses with gL characteristic.
The connection cross-sections are calculated for three-core copper cables installed horizontally in free air at an ambient temperature of 30 °C (86 °F) (in accordance with DIN VDE 0298 Part 2 / Group 5) and the recommended line protection in accordance with DIN VDE 0100 Part 430.
AWG (American Wire Gauge for cross-sections < 120 mm²);
MCM (Mille Circular Mil): American wire gauge for cross-sections > 120 mm².

12.3.1 Power Module

Power Module, 380 V - 480 V 3 AC

Table 12-8 Power Module, 380 V – 480 V 3 AC, part 1

Category	Unit			
Order number **6SL3310-**		**1GE32-1AA0**	**1GE32-6AA0**	**1GE33-1AA0**
Rated motor output At 400 V, 50 Hz At 460 V, 60 Hz	 kW hp	 110 150	 132 200	 160 250
Rated input voltage	V	380 V to 480 V 3 AC ± 10% (-15% < 1 min)		
Rated input current	A	229	284	338
Rated output current	A	210	260	310
Base-load current I_L [1]	A	205	250	302
Base-load current I_H [2]	A	178	233	277
Max. output frequency [3]	Hz	160	160	160
Power loss	kW	2.46	3.27	4
Max. current requirements (at 24 V DC)	A	0.8	0.8	0.9
Cooling air requirement	m³/s	0.17	0.23	0.36
Sound pressure level at 50/60 Hz	dB(A)	64/67	64/67	69/73
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 185 2 x (350) M10	 2 x 185 2 x (350) M10	 2 x 240 2 x (500) M10
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 185 2 x (350) M10	 2 x 185 2 x (350) M10	 2 x 240 2 x (500) M10
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 185 2 x (350) 2 x 185 2 x (350) M10	 2 x 185 2 x (350) 2 x 185 2 x (350) M10	 2 x 240 2 x (500) 2 x 240 2 x (500) M10
Frame size		FX	FX	GX
Approx. weight	kg	104	104	162
Dimensions (W x H x D)	mm	326 x 1,400 x 356	326 x 1,400 x 356	326 x 1,533 x 545
Recommended protection Line protection w/o semicond. protection, Rated current, frame size in accordance with DIN 43620-1 Line and semicond. protection [4] Rated current, frame size to DIN 43620-1	 A A	 3NA3252 315 2 3NE1230-2 315 1	 3NA3354 355 3 3NE1331-2 350 2	 3NA3365 500 3 3NE1334-2 500 2

[1] The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[2] The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[4] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12-9 Power Module, 380 V – 480 V 3 AC, part 2

Category	Unit			
Order number **6SL3310-**		**1GE33-8AA0**	**1GE35-0AA0**	**1GE36-1AA0**
Rated motor output At 400 V, 50 Hz At 460 V, 60 Hz	 kW hp	 200 300	 250 400	 315 500
Rated input voltage	V	380 V to 480 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	395	509	629
Rated output current	A	380	490	605
Base-load current I_L [1]	A	370	477	590
Base-load current I_H [2]	A	340	438	460
Max. output frequency [3]	Hz	160	160	100
Power loss	kW	4.54	5.78	7.8
Max. current requirements (at 24 V DC)	A	0.9	0.9	1
Cooling air requirement	m³/s	0.36	0.36	0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	70/73
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm²	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm²	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm²	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 4 x 240 4 x (500) M12
Frame size		GX	GX	HX
Approx. weight	kg	162	162	294
Dimensions (W x H x D)	mm	326 x 1,533 x 545	326 x 1,533 x 545	503 x 1,506 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size in accordance with DIN 43620-1 Line and semicond. protection [4] Rated current, frame size to DIN 43620-1	 A A	 3NA3365 500 3 3NE1334-2 500 2	 3NA3372 630 3 3NE1436-2 630 3	 3NA3475 800 3 3NE1438-2 800 3

[1] The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[2] The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[4] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12-10 Power Module, 380 V – 480 V 3 AC, part 3

Category	Unit			
Order number **6SL3310-**		**1GE37-5AA0**	**1GE38-4AA0**	**1GE41-0AA0**
Rated motor output At 400 V, 50 Hz At 460 V, 60 Hz	 kW hp	 400 600	 450 700	 560 800
Rated input voltage	V	380 V to 480 V 3 AC ± 10% (-15% < 1 min)		
Rated input current	A	775	873	1024
Rated output current	A	745	840	985
Base-load current I_L 1)	A	725	820	960
Base-load current I_H 2)	A	570	700	860
Max. output frequency 3)	Hz	100	100	100
Power loss	kW	9.1	9.6	13.8
Max. current requirements (at 24 V DC)	A	1	1	1.25
Cooling air requirement	m³/s	0.78	0.78	1.48
Sound pressure level at 50/60 Hz	dB(A)	70/73	70/73	72/75
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 4 x 240 4 x (500) M12	 2 x 240 2 x (500) 4 x 240 4 x (500) M12	 4 x 240 4 x (500) 6 x 240 6 x (500) M12
Frame size		HX	HX	JX
Approx. weight	kg	294	294	530
Dimensions (W x H x D)	mm	503 x 1,506 x 540	503 x 1,506 x 540	908.5 x 1,510 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size in accordance with DIN 43620-1 Line and semicond. protection 4) Rated current, frame size to DIN 43620-1	 A A	 3NA3475 800 3 3NE1448-2 850 3	 Circuit breaker --- --- Circuit breaker --- ---	 Circuit breaker --- --- Circuit breaker --- ---

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

4) The types of protection specified here are mandatory for installing a UL-approved system.

Power Module, 500 V - 600 V 3 AC

Table 12-11 Power Module, 500 V – 600 V 3 AC, part 1

Category	Unit			
Order number **6SL3310-**		**1GF31-8AA0**	**1GF32-2AA0**	**1GF32-6AA0**
Rated motor output At 500 V, 50 Hz At 575 V, 60 Hz	 kW hp	 110 150	 132 200	 160 250
Rated input voltage	V	500 V to 600 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	191	224	270
Rated output current	A	175	215	260
Base-load current I_L [1]	A	171	208	250
Base-load current I_H [2]	A	157	192	233
Max. output frequency [3]	Hz	100	100	100
Power loss	kW	3.0	3.4	3.9
Max. current requirements (at 24 V DC)	A	0.9	0.9	0.9
Cooling air requirement	m³/s	0.36	0.36	0.36
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	69/73
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 2 x 240 2 x (500) M10
Frame size		GX	GX	GX
Approx. weight	kg	162	162	162
Dimensions (W x H x D)	mm	326 x 1,533 x 545	326 x 1,533 x 545	326 x 1,533 x 545
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semicond. protection [4] Rated current, frame size to DIN 43620-1	 A A 	 3NA3244-6 250 2 3NE1227-2 250 1	 3NA3252-6 315 2 3NE1230-2 315 1	 3NA3354-6 355 3 3NE1331-2 350 2

[1] The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[2] The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[4] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12-12 Power Module, 500 V – 600 V 3 AC, part 2

Category	Unit			
Order number **6SL3310-**		**1GF33-3AA0**	**1GF34-1AA0**	**1GF34-7AA0**
Rated motor output At 500 V, 50 Hz At 575 V, 60 Hz	 kW hp	 200 300	 250 400	 315 450
Rated input voltage	V	500 V to 600 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	343	426	483
Rated output current	A	330	410	465
Base-load current I_L [1]	A	320	400	452
Base-load current I_H [2]	A	280	367	416
Max. output frequency [3]	Hz	100	100	100
Power loss	kW	4.9	6.4	7.3
Max. current requirements (at 24 V DC)	A	0.9	1	1
Cooling air requirement	m³/s	0.36	0.78	0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	70/73	70/73
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 4 x 240 4 x (500) M12	 2 x 240 2 x (500) 4 x 240 4 x (500) M12
Frame size		GX	HX	HX
Approx. weight	kg	162	294	294
Dimensions (W x H x D)	mm	326 x 1,533 x 545	503 x 1,506 x 540	503 x 1,506 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semicond. protection [4] Rated current, frame size to DIN 43620-1	 A A 	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3252-6 2 x 315 2 3NE1435-2 560 3

[1] The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[2] The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[4] The types of protection specified here are mandatory for installing a UL-approved system.

Table 12-13 Power Module, 500 V – 600 V 3 AC, part 3

Category	Unit			
Order number **6SL3310-**		**1GF35-8AA0**	**1GF37-4AA0**	**1GF38-1AA0**
Rated motor output At 500 V, 50 Hz At 575 V, 60 Hz	 kW hp	 400 500	 500 700	 560 800
Rated input voltage	V	500 V to 600 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	598	764	842
Rated output current	A	575	735	810
Base-load current I_L [1]	A	560	710	790
Base-load current I_H [2]	A	514	657	724
Max. output frequency [3]	Hz	100	100	100
Power loss	kW	8.1	12.0	13.3
Max. current requirements (at 24 V DC)	A	1	1.25	1.25
Cooling air requirement	m³/s	0.78	1.48	1.48
Sound pressure level at 50/60 Hz	dB(A)	70/73	73/75	73/75
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm²	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12	 6 x 240 6 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm²	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12	 6 x 240 6 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm²	 2 x 240 2 x (500) 4 x 240 4 x (500) M12	 2 x 240 2 x (500) 6 x 240 6 x (500) M12	 2 x 240 2 x (500) 6 x 240 6 x (500) M12
Frame size		HX	JX	JX
Approx. weight	kg	294	530	530
Dimensions (W x H x D)	mm	503 x 1,506 x 540	908.5 x 1,510 x 540	908.5 x 1,510 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semicond. protection [4] Rated current, frame size to DIN 43620-1	 A A	 3NA3354-6 2 x 355 3 3NE1447-2 670 3	 3NA3365-6 2 x 500 3 3NE1448-2 850 3	 Circuit breaker --- --- Circuit breaker --- ---

[1] The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[2] The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

[3] Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

[4] The types of protection specified here are mandatory for installing a UL-approved system.

Power Module, 660 V - 690 V 3 AC

Table 12-14 Power Module, 660 V – 690 V 3 AC, part 1

Category	Unit			
Order number **6SL3310-**		**1GH28-5AA0**	**1GH31-0AA0**	**1GH31-2AA0**
Rated motor output	kW	75	90	110
Rated input voltage	V	660 V to 690 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	93	109	131
Rated output current	A	85	100	120
Base-load current I_L 1)	A	80	95	115
Base-load current I_H 2)	A	76	89	107
Max. output frequency 3)	Hz	100	100	100
Power loss	kW	1.5	1.8	2.4
Max. current requirements (at 24 V DC)	A	0.8	0.8	0.8
Cooling air requirement	m³/s	0.17	0.17	0.17
Sound pressure level at 50/60 Hz	dB(A)	64/67	64/67	64/67
Line connection				
Maximum: DIN VDE	mm²	2 x 185	2 x 185	2 x 185
AWG/MCM		2 x (350)	2 x (350)	2 x (350)
Fixing screw		M10	M10	M10
Motor connection				
Maximum: DIN VDE	mm²	2 x 185	2 x 185	2 x 185
AWG/MCM		2 x (350)	2 x (350)	2 x (350)
Fixing screw		M10	M10	M10
Protective conductor connection				
Max. PE1/GND	mm²	2 x 185	2 x 185	2 x 185
AWG/MCM		2 x (350)	2 x (350)	2 x (350)
Max. PE2/GND	mm²	2 x 185	2 x 185	2 x 185
AWG/MCM		2 x (350)	2 x (350)	2 x (350)
Fixing screw		M10	M10	M10
Frame size		FX	FX	FX
Approx. weight	kg	104	104	104
Dimensions (W x H x D)	mm	326 x 1,400 x 356	326 x 1,400 x 356	326 x 1,400 x 356
Recommended protection				
Line protection				
w/o semicond. protection		3NA3132-6	3NA3132-6	3NA3136-6
Rated current,	A	125	125	160
frame size to DIN 43620-1		1	1	1
Line and semi-cond. protection		3NE1022-2	3NE1022-2	3NE1224-2
Rated current,	A	125	125	160
frame size to DIN 43620-1		00	00	1

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

Table 12-15 Power Module, 660 V – 690 V 3 AC, part 2

Category	Unit			
Order number **6SL3310-**		**1GH31-5AA0**	**1GH31-8AA0**	**1GH32-2AA0**
Rated motor output	kW	132	160	200
Rated input voltage	V	660 V to 690 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	164	191	224
Rated output current	A	150	175	215
Base-load current I_L 1)	A	142	171	208
Base-load current I_H 2)	A	134	157	192
Max. output frequency 3)	Hz	100	100	100
Power loss	kW	2.5	3.8	4.8
Max. current requirements (at 24 V DC)	A	0.8	0.9	0.9
Cooling air requirement	m³/s	0.17	0.36	0.36
Sound pressure level at 50/60 Hz	dB(A)	64/67	69/73	69/73
Line connection				
Maximum: DIN VDE AWG/MCM	mm²	2 x 185 2 x (350)	2 x 240 2 x (500)	2 x 240 2 x (500)
Fixing screw		M10	M10	M10
Motor connection				
Maximum: DIN VDE AWG/MCM	mm²	2 x 185 2 x (350)	2 x 240 2 x (500)	2 x 240 2 x (500)
Fixing screw		M10	M10	M10
Protective conductor connection				
Max. PE1/GND AWG/MCM	mm² 	2 x 185 2 x (350)	2 x 240 2 x (500)	2 x 240 2 x (500)
Max. PE2/GND AWG/MCM	mm² 	2 x 185 2 x (350)	2 x 240 2 x (500)	2 x 240 2 x (500)
Fixing screw		M10	M10	M10
Frame size		FX	GX	GX
Approx. weight	kg	104	162	162
Dimensions (W x H x D)	mm	326 x 1,400 x 356	326 x 1,533 x 545	326 x 1,533 x 545
Recommended protection				
Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1	 A 	 3NA3240-6 200 2	 3NA3244-6 250 2	 3NA3252-6 315 2
Line and semi-cond. protection Rated current, frame size to DIN 43620-1	 A 	3NE1225-2 200 1	3NE1227-2 250 1	3NE1230-2 315 1

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

Table 12-16 Power Module, 660 V – 690 V 3 AC, part 3

Category	Unit			
Order number **6SL3310-**		**1GH32-6AA0**	**1GH33-3AA0**	**1GH34-1AA0**
Rated motor output	kW	250	315	400
Rated input voltage	V	660 V to 690 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	270	343	426
Rated output current	A	260	330	410
Base-load current I_L 1)	A	250	320	400
Base-load current I_H 2)	A	233	280	367
Max. output frequency 3)	Hz	100	100	100
Power loss	kW	5.0	5.8	7.5
Max. current requirements (at 24 V DC)	A	0.9	0.9	1
Cooling air requirement	m³/s	0.36	0.36	0.78
Sound pressure level at 50/60 Hz	dB(A)	69/73	69/73	70/73
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 2 x 240 2 x (500) M10	 2 x 240 2 x (500) M10	 4 x 240 4 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 2 x 240 2 x (500) M10	 2 x 240 2 x (500) 4 x 240 4 x (500) M12
Frame size		GX	GX	HX
Approx. weight	kg	162	162	294
Dimensions (W x H x D)	mm	326 x 1,533 x 545	326 x 1,533 x 545	503 x 1,506 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semi-cond. protection Rated current, frame size to DIN 43620-1	 A A 	 3NA3354-6 355 3 3NE1331-2 350 2	 3NA3365-6 500 3 3NE1334-2 500 2	 3NA3365-6 500 3 3NE1334-2 500 2

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

Table 12-17 Power Module, 660 V – 690 V 3 AC, part 4

Category	Unit			
Order number **6SL3310-**		**1GH34-7AA0**	**1GH35-8AA0**	**1GH37-4AA0**
Rated motor output	kW	450	560	710
Rated input voltage	V	660 V to 690 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	483	598	764
Rated output current	A	465	575	735
Base-load current I_L 1)	A	452	560	710
Base-load current I_H 2)	A	416	514	657
Max. output frequency 3)	Hz	100	100	100
Power loss	kW	8.5	10.3	12.8
Max. current requirements (at 24 V DC)	A	1	1	1.25
Cooling air requirement	m³/s	0.78	0.78	1.48
Sound pressure level at 50/60 Hz	dB(A)	70/73	70/73	73/75
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 4 x 240 4 x (500) M12	 4 x 240 4 x (500) M12	 6 x 240 6 x (500) M12
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 4 x 240 4 x (500) M12	 2 x 240 2 x (6,500) 4 x 240 4 x (500) M12	 2 x 240 2 x (500) 6 x 240 6 x (500) M12
Frame size		HX	HX	JX
Approx. weight	kg	294	294	530
Dimensions (W x H x D)	mm	503 x 1,506 x 540	503 x 1,506 x 540	908.5 x 1,510 x 540
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semi-cond. protection Rated current, frame size to DIN 43620-1	 A A	 3NA3252-6 2 x 315 2 3NE1435-2 560 3	 3NA3354-6 2 x 355 3 3NE1447-2 670 3	 3NA3365-6 2 x 500 3 3NE1448-2 850 3

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

Table 12-18 Power Module, 660 V – 690 V 3 AC, part 5

Category	Unit			
Order number **6SL3310-**		**1GH38-1AA0**		
Rated motor output	kW	800		
Rated input voltage	V	660 V to 690 V 3 AC ±10% (-15% < 1 min)		
Rated input current	A	842		
Rated output current	A	810		
Base-load current I_L 1)	A	790		
Base-load current I_H 2)	A	724		
Max. output frequency 3)	Hz	100		
Power loss	kW	13.9		
Max. current requirements (at 24 V DC)	A	1.25		
Cooling air requirement	m³/s	1.48		
Sound pressure level at 50/60 Hz	dB(A)	73/75		
Line connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 6 x 240 6 x (500) M12		
Motor connection Maximum: DIN VDE AWG/MCM Fixing screw	 mm² 	 6 x 240 6 x (500) M12		
Protective conductor connection Max. PE1/GND AWG/MCM Max. PE2/GND AWG/MCM Fixing screw	 mm² mm² 	 2 x 240 2 x (500) 6 x 240 6 x (500) M12		
Frame size		JX		
Approx. weight	kg	530		
Dimensions (W x H x D)	mm	908.5 x 1,510 x 540		
Recommended protection Line protection w/o semicond. protection Rated current, frame size to DIN 43620-1 Line and semi-cond. protection Rated current, frame size to DIN 43620-1	 A A	 Circuit breaker --- --- Circuit breaker --- ---		

1) The base-load current (I_L) is based on a duty cycle of 110% for 60 s or 150% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

2) The base-load current (I_H) is based on a duty cycle of 150% for 60 s or 160% for 10 s with a duty cycle duration of 300 s (see "Overload capability").

3) Maximum output frequency at factory-set default pulse frequency (for information on increasing the output frequency, see "Functions, monitoring and protective functions/Increasing the output frequency"; for information on derating data, see "Derating data").

12.3.2 Control Unit CU320

Table 12-19 CU320

Max. current requirements (at 24 V DC) (not taking into account digital outputs, option slot extension)	0.8 A
Max. connectable cross section	2.5 mm^2
Digital inputs	8 floating digital inputs 8 bidirectional, non-floating digital inputs/outputs
Voltage	-3 V to 30 V
Low level (an open digital input is interpreted as "low")	-3 V to 5 V
High level	15 V to 30 V
Current consumption (typ. at 24 V DC)	10 mA
Max. connectable cross section	0.5 mm^2
Digital outputs (continued-short-circuit-proof)	8 bidirectional, non-floating digital outputs/inputs
Voltage	24 V DC
Max. load current per digital output	500 mA
Max. connectable cross section	0.5 mm^2
Power loss	20 W
PE connection	On housing with M5 screw
Ground connection	On housing with M5 screw
Width	50 mm
Height	270 mm
Depth	226 mm
Weight, approx.	1.5 kg

12.3.3 TM31 Terminal Module

Table 12-20 Technical specifications TM31

Max. current requirement (at 24 V DC), not taking into account digital outputs	0.5 A
Max. connectable cross section	2.5 mm^2
Digital inputs	
Voltage	-3 V to 30 V
Low level (an open digital input is interpreted as "low")	-3 V to 5 V
High level	15 V to 30 V
Current consumption (at 24 V DC)	10 mA
Signal propagation times of the digital inputs	L -> H: 50 µs H->L: 100 µs
Max. connectable cross section	1.5 mm^2
Digital outputs (continued-short-circuit-proof)	
Voltage	24 V DC
Max. load current per digital output	External/internal 24 V supply 100 mA / 20 mA
Max. connectable cross section	1.5 mm^2
Analog inputs (switching between the voltage and current input via the switch)	
As voltage input	
- Voltage range	-10 V to 10 V
- Internal resistance Ri	70 kΩ
As current input	
- Current range	4 mA to 20 mA, -20 mA to 20 mA, 0 mA to 20 mA
- Internal resistance Ri	250 Ω
- Resolution	12 bits
Max. connectable cross section	1.5 mm^2
Analog outputs (continued-short-circuit-proof)	
Voltage range	-10 V to 10 V
Max. load current	-3 mA to 3 mA
Current range	4 mA to 20 mA, -20 mA to 20 mA, 0 mA to 20 mA
Max. load resistance	500 Ω for outputs in the range -20 mA to 20 mA
Resolution	12 bits
Max. connectable cross section	1.5 mm^2
Relay outputs (two-way contacts)	
Max. load current	8 A
Max. switching voltage	250 V AC, 30 V DC
Max. switching power (at 250 V AC)	2000 VA
Max. switching power (at 30 V DC)	240 W (ohmic load)
Required minimum current	100 mA

Max. connectable cross section	2.5 mm^2
Power loss	< 10 W
PE connection	On housing with M4 screw
Width	50 mm
Height	150 mm
Depth	119 mm
Weight, approx.	0.87 kg

12.3.4 SMC30 Sensor Module

Table 12-21 Technical specifications SMC30

Electronics power supply	
Voltage	24 V DC (20.4 – 28.8)
Current	max. 0.6 A
Max. ambient temperature up to an altitude of 2000 m	55 °C
Note: As of an altitude of 2000 m, the max. ambient temperature decreases by 7°C every 1000 m.	
PE/ground connection	On housing with M4/1.8 Nm screw
Weight	0.8 kg

Appendix

A

A.1 List of abbreviations

A	
A...	Alarm
AC	Alternating current
AI	Analog input
AO	Analog output
AOP	Advanced operator panel (with plain-text display)
B	
BI	Binector input
BICO	Binector/connector
BO	Binector output
C	
C	Capacitance
CAN	Serial bus system
CB	Communication board
CDS	Command data set
CI	Connector input
COM	Center contact on a changeover contact
CU	Control Unit
D	
DC	Direct current
DDS	Drive data set
DI	Digital input
DI/DO	Digital input/output bidirectional
DO	Digital output
E	
ESD	Electrostatic devices
EMC	Electromagnetic compatibility
EN	European standard
F	
F ...	Fault
FAQ	Frequently asked questions
FW	Firmware
H	

RFG	Ramp-function generator
HW	Hardware
I	
I/O	Input/output
IEC	International electrical engineering standard
IGBT	Insulated gate bipolar transistor
J	
JOG	Jog mode
L	
L	Inductance
LED	Light-emitting diode
M	
M	Ground
MDS	Motor data set
N	
NC	Normally closed contact
NEMA	Standardization body in the USA (United States of America)
NO	Normally open contact
P	
p ...	Adjustable parameter
PDS	Power unit data set
PE	Protective earth
PROFIBUS	Serial data bus
PTC	Positive temperature coefficient
R	
r...	Visualization parameter (read-only)
RAM	Read and write memory
RS 232	Serial interface
RS 485	Standard. Describes the physical characteristics of a digital serial interface.
S	
SI	Safety Integrated
STW	PROFIdrive control word
SW	Software
T	
TIA	Totally Integrated Automation
TM	Terminal Module
U	
UL	Underwriters Laboratories Inc.
V	
Vdc	DC link voltage
Z	
ZSW	PROFIdrive status word

A.2 Parameter macros

Parameter macro p0015 = G130 built-in unit

This macro is used to make default settings for operating the built-in unit.

Table A-1 Parameter macro p0015 = G130 built-in unit

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0400[0]	Enc type selection	Vector	9999	Other	Vector
p0404[0]	Encoder configuration effective	Vector	200008h		Vector
p0405[0]	Square-wave encoder track A/B	Vector	9h	Bipolar, like A/B track	Vector
p0408[0]	Rotary encoder pulse No.	Vector	1024	1024 pulses per revolution	Vector
p0420[0]	Encoder connection	Vector	0x2	Encoder connection = terminal	Vector
p0500	Technology application	Vector	1	Pumps, fans	Vector
p0600	Motor temperature sensor for monitoring	Vector	0	No sensor	Vector
p0601	Motor temperature sensor type	Vector	0	No sensor	Vector
p0603[0]	CI: Motor temperature	Vector	r4105	Sensor on TM31	TM31
p0603[1]	CI: Motor temperature	Vector			
p0604	Motor overtemperature alarm threshold	Vector	120	(Factory setting)	Vector
p0605	Motor overtemperature fault threshold	Vector	155	(Factory setting)	Vector
p0606	Motor overtemperature timer	Vector	0	(Factory setting)	Vector
p0610	Response to motor overtemperature condition	Vector	1	Display fault, for alarm Imax red.	Vector
p0700[0]	Macro binector input (BI)	Vector	70001	PROFIdrive	Vector
p0864	BI: Infeed operation	Vector	1		
p1000[0]	Macro connector inputs (CI) for speed setpoints	Vector	10001	PROFIdrive	Vector
p1001	CO: Fixed speed setpoint 1	Vector	300 rpm		Vector
p1002	CO: Fixed speed setpoint 2	Vector	600 rpm		Vector
p1003	CO: Fixed speed setpoint 3	Vector	1500 rpm		Vector
p1083	CO: Speed limit in positive direction of rotation	Vector	6000 rpm		Vector
p1086	CO: Speed limit in negative direction of rotation	Vector	-6000 rpm		Vector
p1115	Ramp-function generator selection	Vector	1	Extended RFG	Vector
p1120	Ramp-function generator ramp-up time	Vector	20 s		Vector
p1121	Ramp-function generator ramp-down time	Vector	30 s		Vector
p1135	OFF3 ramp-down time	Vector	10 s		Vector
p1200	FlyRest oper mode	Vector	0	Flying restart not active	Vector

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p1240	Vdc controller configuration	Vector	1	Vdc-max controller enabled	Vector
p1280	Vdc controller configuration (V/f)	Vector	1	Vdc-max controller enabled	Vector
p1300	Open-loop/closed-loop control operating mode	Vector	20	Sensorless speed control	Vector
p1911	Number of phases to be identified	Vector	3	3 phases	Vector
p2051[0]	CI: PROFIBUS PZD send word	Vector	r2089[0]	STW1	Vector
p2051[1]	CI: PROFIBUS PZD send word	Vector	r0063	n-act	Vector
p2051[2]	CI: PROFIBUS PZD send word	Vector	r0068	I-act	Vector
p2051[3]	CI: PROFIBUS PZD send word	Vector	r0080	M-act	Vector
p2051[4]	CI: PROFIBUS PZD send word	Vector	r0082	P-act	Vector
p2051[5]	CI: PROFIBUS PZD send word	Vector	r2131	FAULT	Vector
p2080[0]	BI: PROFIBUS send status word 1	Vector	r0899[0]	Ready to power up	Vector
p2080[1]	BI: PROFIBUS send status word 1	Vector	r0899[1]	Ready to operate	Vector
p2080[2]	BI: PROFIBUS send status word 1	Vector	r0899[2]	Operation enabled	Vector
p2080[3]	BI: PROFIBUS send status word 1	Vector	r2139[3]	Fault	Vector
p2080[4]	BI: PROFIBUS send status word 1	Vector	r0899[4]	No OFF2	Vector
p2080[5]	BI: PROFIBUS send status word 1	Vector	r0899[5]	No OFF3	Vector
p2080[6]	BI: PROFIBUS send status word 1	Vector	r0899[6]	Power-on inhibit	Vector
p2080[7]	BI: PROFIBUS send status word 1	Vector	r2139[7]	Alarm present	Vector
p2080[8]	BI: PROFIBUS send status word 1	Vector	r2197[7]	Setpoint/actual value deviation in tolerance	Vector
p2080[9]	BI: PROFIBUS send status word 1	Vector	r0899[9]	Control from PLC	Vector
p2080[10]	BI: PROFIBUS send status word 1	Vector	r2199[1]	Comparison value reached	Vector
p2080[11]	BI: PROFIBUS send status word 1	Vector	r1407[7]	M/I/P limiting not active	Vector
p2080[12]	BI: PROFIBUS send status word 1	Vector	0		Vector
p2080[13]	BI: PROFIBUS send status word 1	Vector	r2129[14]	No alarm for motor overtemperature	Vector
p2080[14]	BI: PROFIBUS send status word 1	Vector	r2197[3]	Clockwise	Vector
p2080[15]	BI: PROFIBUS send status word 1	Vector	r2129[15]	No warning of power unit temperature overload	Vector
p2088	PROFIBUS Invert status word	Vector	B800h		Vector
p2128[14]	Select fault/alarm code for trigger	Vector	7910	Alarm, motor overtemperature	Vector
p2128[15]	Select fault/alarm code for trigger	Vector	5000	Warning of power unit temperature overload	Vector
p2153	Time constant revolutions actual value filter	Vector	20 ms		Vector
p7003	Winding system	Vector	1	Separate winding systems	Vector

Parameter macro p0700 = 1: PROFIdrive (70001)

This macro is used to set the PROFIdrive interface as the default command source.

Table A-2 Parameter macro p0700 = 1: PROFIdrive

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	r2090.0	PZD 1 bit 0	Vector
p0844[0]	No OFF2_1	Vector	r2090.1	PZD 1 bit 1	Vector
p0845[0]	No OFF2_2	Vector	r0722.4	CU DI4	CU
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r0722.5	CU DI5	CU
p0806	Inhibit LOCAL mode	Vector	0		
p0810	Switchover CDS bit 0	Vector	0		
p0852	Enable operation	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control from PLC	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	0		
p1021	FSW bit 1	Vector	0		
p1035	MOP raise	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	MOP lower	Vector	r2090.14	PZD 1 bit 14	Vector
p1055	Jog bit 0	Vector	0		
p1056	Jog bit 1	Vector	0		
p1113	Direction reversal	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	Enable RFG	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Start RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	Enable nsetp	Vector	r2090.6	PZD 1 bit 6	Vector
p2103	1. Acknowledge faults	Vector	r2090.7	PZD 1 bit 7	Vector
p2104	2. Acknowledge faults	Vector	r0722.3	CU DI3	TM31
p2106	Ext. fault_1	Vector	r0722.6	CU DI6	CU
p2107	Ext. fault_2	Vector	1		
p2112	Ext. alarm_1	Vector	r0722.11	CU DI11	CU
p2116	Ext. alarm_2	Vector	1		
p0738	DI/DO8	CU	r0899.11	Pulses enabled	Vector
p0748[8]	Invert DI/DO8	CU	0	Not inverted	
p0728[8]	Set DI/DO8 input or output	CU	1	Output	CU
p0739	DI/DO9	CU	r2139.3	Fault active	Vector
p0748[9]	Invert DI/DO9	CU	1	inverted	
p0728[9]	Set DI/DO9 input or output	CU	1	Output	CU
p0740	DI/DO10	CU	1	+24 V	CU
p0748[10]	Invert DI/DO10	CU	0	Not inverted	
p0728[10]	Set DI/DO10 input or output	CU	1	Output	CU
p0741	DI/DO11	CU	0		CU
p0748[11]	Invert DI/DO11	CU	0	Not inverted	

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0728[11]	Set DI/DO11 input or output	CU	0	Input	CU
p0742	DI/DO12	CU	r2138.7	Ack. fault	Vector
p0748[12]	Invert DI/DO12	CU	0	Not inverted	
p0728[12]	Set DI/DO12 input or output	CU	1	Output	CU
p0743	DI/DO13	CU	1	+24 V	CU
p0748[13]	Invert DI/DO13	CU	0	Not inverted	
p0728[13]	Set DI/DO13 input or output	CU	1	Output	CU
p0744	DI/DO14	CU	1	+24 V	CU
p0748[14]	Invert DI/DO14	CU	0	Not inverted	
p0728[14]	Set DI/DO14 input or output	CU	1	Output	CU
p0745	DI/DO15	CU	1	+24 V	CU
p0748[15]	Invert DI/DO15	CU	0	Not inverted	
p0728[15]	Set DI/DO15 input or output	CU	1	Output	CU

Parameter macro p0700 = 2: Terminal TM31 (70002)

This macro is used to set terminal block TM31 as the command source.

Table A-3 Parameter macro p0700 = 2: TM31 terminals

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	r4022.0	TM31 DI0	TM31
p0844[0]	No OFF2_1	Vector	1		
p0845[0]	No OFF2_2	Vector	r4022.4	TM31 DI4	TM31
p0848[0]	No OFF3_1	Vector	1		
p0849[0]	No OFF3_2	Vector	r4022.5	TM31 DI5	TM31
p0806	Inhibit LOCAL mode	Vector	0		
p0810	Switchover CDS bit 0	Vector	0		
p0852	Enable operation	Vector	1		
p0854	Control from PLC	Vector	1		
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r4022.1	TM31 DI1	TM31
p1021	FSW bit 1	Vector	r4022.2	TM31 DI2	TM31
p1035	MOP raise	Vector	r4022.1	TM31 DI1	TM31
p1036	MOP lower	Vector	r4022.2	TM31 DI2	TM31
p1055	Jog bit 0	Vector	0		
p1056	Jog bit 1	Vector	0		
p1113	Direction reversal	Vector	0		
p1140	Enable RFG	Vector	1		
p1141	Start RFG	Vector	1		
p1142	Enable nsetp	Vector	1		
p2103	1. Acknowledge faults	Vector	0		
p2104	2. Acknowledge faults	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r4022.6	TM31 DI6	TM31
p2107	Ext. fault_2	Vector	1		
p2112	Ext. alarm_1	Vector	r4022.11	TM31 DI11	TM31
p2116	Ext. alarm_2	Vector	1		
p0738	DI/DO8	CU		(Factory setting)	
p0748[8]	Invert DI/DO8	CU		(Factory setting)	
p0728[8]	Set DI/DO8 input or output	CU		(Factory setting)	
p0739	DI/DO9	CU		(Factory setting)	
p0748[9]	Invert DI/DO9	CU		(Factory setting)	
p0728[9]	Set DI/DO9 input or output	CU		(Factory setting)	
p0740	DI/DO10	CU		(Factory setting)	
p0748[10]	Invert DI/DO10	CU		(Factory setting)	
p0728[10]	Set DI/DO10 input or output	CU		(Factory setting)	
p0741	DI/DO11	CU		(Factory setting)	
p0748[11]	Invert DI/DO11	CU		(Factory setting)	

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0728[11]	Set DI/DO11 input or output	CU		(Factory setting)	
p0742	DI/DO12	CU	r2138.7	Ack. fault	Vector
p0748[12]	Invert DI/DO12	CU	0	Not inverted	
p0728[12]	Set DI/DO12 input or output	CU	1	Output	CU
p0743	DI/DO13	CU		(Factory setting)	
p0748[13]	Invert DI/DO13	CU		(Factory setting)	
p0728[13]	Set DI/DO13 input or output	CU		(Factory setting)	
p0744	DI/DO14	CU		(Factory setting)	
p0748[14]	Invert DI/DO14	CU		(Factory setting)	
p0728[14]	Set DI/DO14 input or output	CU		(Factory setting)	
p0745	DI/DO15	CU		(Factory setting)	
p0748[15]	Invert DI/DO15	CU		(Factory setting)	
p0728[15]	Set DI/DO15 input or output	CU		(Factory setting)	
p2103	1. Acknowledge faults	TM31	0		
p2104	2. Acknowledge faults	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4038	DO8	TM31	r0899.0	Ready to start	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	TM31
p4039	DO9	TM31		(Factory setting)	
p4028.9	Set DI/DO9 input or output	TM31		(Factory setting)	
p4040	DO10	TM31		(Factory setting)	
p4028.10	Set DI/DO10 input or output	TM31		(Factory setting)	
p4041	DO11	TM31		(Factory setting)	
p4028.11	Set DI/DO11 input or output	TM31		(Factory setting)	

Parameter macro p0700 = 3: CU terminals (70003)

This macro is used to set the CU320 terminals as the command source.

Table A-4 Parameter macro p0700 = 3: CU terminals

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	r0722.0	CU DI0	CU
p0844[0]	No OFF2_1	Vector	1		Vector
p0845[0]	No OFF2_2	Vector	r0722.4	CU DI4	CU
p0848[0]	No OFF3_1	Vector	1		Vector
p0849[0]	No OFF3_2	Vector	r0722.5	CU DI5	CU
p0806	Inhibit LOCAL mode	Vector	0		
p0810	Switchover CDS bit 0	Vector	0		
p0852	Enable operation	Vector	1		Vector
p0854	Control from PLC	Vector	1		Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	r0722.1	CU DI1	CU
p1021	FSW bit 1	Vector	r0722.2	CU DI2	CU
p1035	MOP raise	Vector	r0722.1	CU DI1	CU
p1036	MOP lower	Vector	r0722.2	CU DI2	CU
p1055	Jog bit 0	Vector	0		
p1056	Jog bit 1	Vector	0		
p1113	Direction reversal	Vector	0		
p1140	Enable RFG	Vector	1		Vector
p1141	Start RFG	Vector	1		Vector
p1142	Enable nsetp	Vector	1		Vector
p2103	1. Acknowledge faults	Vector	0		
p2104	2. Acknowledge faults	Vector	r0722.3	CU DI3	TM31
p2106	Ext. fault_1	Vector	r0722.6	CU DI6	CU
p2107	Ext. fault_2	Vector	1		
p2112	Ext. alarm_1	Vector	r0722.11	CU DI11	CU
p2116	Ext. alarm_2	Vector	1		
p0738	DI/DO8	CU	r0899.11	Pulses enabled	Vector
p0748[8]	Invert DI/DO8	CU	0	Not inverted	
p0728[8]	Set DI/DO8 input or output	CU	1	Output	CU
p0739	DI/DO9	CU	r2139.3	Fault active	Vector
p0748[9]	Invert DI/DO9	CU	1	inverted	
p0728[9]	Set DI/DO9 input or output	CU	1	Output	CU
p0740	DI/DO10	CU	1	+24 V	CU
p0748[10]	Invert DI/DO10	CU	0	Not inverted	
p0728[10]	Set DI/DO10 input or output	CU	1	Output	CU
p0741	DI/DO11	CU	0		CU
p0748[11]	Invert DI/DO11	CU	0	Not inverted	

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0728[11]	Set DI/DO11 input or output	CU	0	Input	CU
p0742	DI/DO12	CU	r2138.7	Ack. fault	Vector
p0748[12]	Invert DI/DO12	CU	0	Not inverted	
p0728[12]	Set DI/DO12 input or output	CU	1	Output	CU
p0743	DI/DO13	CU	1	+24 V	CU
p0748[13]	Invert DI/DO13	CU	0	Not inverted	
p0728[13]	Set DI/DO13 input or output	CU	1	Output	CU
p0744	DI/DO14	CU	1	+24 V	CU
p0748[14]	Invert DI/DO14	CU	0	Not inverted	
p0728[14]	Set DI/DO14 input or output	CU	1	Output	CU
p0745	DI/DO15	CU	1	+24 V	CU
p0748[15]	Invert DI/DO15	CU	0	Not inverted	
p0728[15]	Set DI/DO15 input or output	CU	1	Output	CU

Parameter macro p0700 = 4: PROFIdrive+TM31 (70004)

This macro is used to set the PROFIdrive interface and terminal block TM31 as the command source.

Table A-5 Parameter macro p0700 = 4: PROFIdrive+TM31

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0840[0]	ON/OFF1	Vector	r2090.0	PZD 1 bit 0	Vector
p0844[0]	No OFF2_1	Vector	r2090.1	PZD 1 bit 1	Vector
p0845[0]	No OFF2_2	Vector	r4022.4	TM31 DI4	TM31
p0848[0]	No OFF3_1	Vector	r2090.2	PZD 1 bit 2	Vector
p0849[0]	No OFF3_2	Vector	r4022.5	TM31 DI5	TM31
p0806	Inhibit LOCAL mode	Vector	0		
p0810	Switchover CDS bit 0	Vector	0		
p0852	Enable operation	Vector	r2090.3	PZD 1 bit 3	Vector
p0854	Control from PLC	Vector	r2090.10	PZD 1 bit 10	Vector
p0922	Profibus PZD telegram selection	Vector	999	Free telegram configuration	
p1020	FSW bit 0	Vector	0		
p1021	FSW bit 1	Vector	0		
p1035	MOP raise	Vector	r2090.13	PZD 1 bit 13	Vector
p1036	MOP lower	Vector	r2090.14	PZD 1 bit 14	Vector
p1055	Jog bit 0	Vector	0		
p1056	Jog bit 1	Vector	0		
p1113	Direction reversal	Vector	r2090.11	PZD 1 bit 11	Vector
p1140	Enable RFG	Vector	r2090.4	PZD 1 bit 4	Vector
p1141	Start RFG	Vector	r2090.5	PZD 1 bit 5	Vector
p1142	Enable nsetp	Vector	r2090.6	PZD 1 bit 6	Vector
p2103	1. Acknowledge faults	Vector	r2090.7	PZD 1 bit 7	Vector
p2104	2. Acknowledge faults	Vector	r4022.3	TM31 DI3	TM31
p2106	Ext. fault_1	Vector	r4022.6	TM31 DI6	TM31
p2107	Ext. fault_2	Vector	1		
p2112	Ext. alarm_1	Vector	r4022.11	TM31 DI11	TM31
p2116	Ext. alarm_2	Vector	1		
p0738	DI/DO8	CU		(Factory setting)	
p0748[8]	Invert DI/DO8	CU		(Factory setting)	
p0728[8]	Set DI/DO8 input or output	CU		(Factory setting)	
p0739	DI/DO9	CU		(Factory setting)	
p0748[9]	Invert DI/DO9	CU		(Factory setting)	
p0728[9]	Set DI/DO9 input or output	CU		(Factory setting)	
p0740	DI/DO10	CU		(Factory setting)	
p0748[10]	Invert DI/DO10	CU		(Factory setting)	
p0728[10]	Set DI/DO10 input or output	CU		(Factory setting)	
p0741	DI/DO11	CU		(Factory setting)	

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p0748[11]	Invert DI/DO11	CU		(Factory setting)	
p0728[11]	Set DI/DO11 input or output	CU		(Factory setting)	
p0742	DI/DO12	CU	r2138.7	Ack. fault	Vector
p0748[12]	Invert DI/DO12	CU	0	Not inverted	
p0728[12]	Set DI/DO12 input or output	CU	1	Output	CU
p0743	DI/DO13	CU		(Factory setting)	
p0748[13]	Invert DI/DO13	CU		(Factory setting)	
p0728[13]	Set DI/DO13 input or output	CU		(Factory setting)	
p0744	DI/DO14	CU		(Factory setting)	
p0748[14]	Invert DI/DO14	CU		(Factory setting)	
p0728[14]	Set DI/DO14 input or output	CU		(Factory setting)	
p0745	DI/DO15	CU		(Factory setting)	
p0748[15]	Invert DI/DO15	CU		(Factory setting)	
p0728[15]	Set DI/DO15 input or output	CU		(Factory setting)	
p2103	1. Acknowledge faults	TM31	r2090.7	PZD 1 bit 1	Vector
p2104	2. Acknowledge faults	TM31	r4022.3	TM31 DI3	TM31
p4030	DO0	TM31	r0899.11	Pulses enabled	Vector
p4031	DO1	TM31	r2139.3	Fault	Vector
p4038	DO8	TM31	r0899.0	Ready to start	Vector
p4028.8	Set DI/DO8 input or output	TM31	1	Output	TM31
p4039	DO9	TM31		(Factory setting)	
p4028.9	Set DI/DO9 input or output	TM31		(Factory setting)	
p4040	DO10	TM31		(Factory setting)	
p4028.10	Set DI/DO10 input or output	TM31		(Factory setting)	
p4041	DO11	TM31		(Factory setting)	
p4028.11	Set DI/DO11 input or output	TM31		(Factory setting)	

Parameter macro p1000 = 1: PROFIdrive (100001)

This macro is used to set the default setpoint source via PROFIdrive.

Table A-6 Parameter macro p1000 = 1: PROFIdrive

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p1070	Main setpoint	Vector	r2050[1]	PROFIdrive PZD2	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 2: Terminal TM31 (100002)

This macro is used to set analog input 0 on customer terminal block TM31 as the setpoint source.

Table A-7 Parameter macro p1000 = 2: TM31 terminals

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p1070	Main setpoint	Vector	r4055	AI0 TM31	TM31
p1071	Main setpoint scaling	Vector	1	100 %	TM31
p1075	Supplementary setpoint	Vector	0		TM31
p1076	Supplementary setpoint scaling	Vector	1	100 %	TM31

Parameter macro p1000 = 3: Motorized potentiometer (100003)

This macro is used to set the motorized potentiometer as the setpoint source.

Table A-8 Parameter macro p1000 = 3: Motorized potentiometer

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p1070	Main setpoint	Vector	r1050	Motorized potentiometer	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

Parameter macro p1000 = 4: Fixed setpoint (100004)

This macro is used to set the fixed setpoint as the setpoint source.

Table A-9 Parameter macro p1000 = 4: Fixed setpoint

Sink			Source		
Parameters	**Description**	**DO**	**Parameters**	**Description**	**DO**
p1070	Main setpoint	Vector	r1024	Active fixed setpoint	Vector
p1071	Main setpoint scaling	Vector	1	100 %	Vector
p1075	Supplementary setpoint	Vector	0		Vector
p1076	Supplementary setpoint scaling	Vector	1	100 %	Vector

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